_____UNIVERSITY OF KENTUCKY_____

University Senate Council
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25 March 2002

TO: Members, University Senate

FROM: University Senate Council

RE: Course/Program Actions: Effective Date: Fall Semester, 2002, UNLESS OTHERWISE NOTED.

The Senate Council circulates for your approval the following curricular actions. Objections will be accepted from University Senators and faculty members and must be received within ten days of receipt of this notice. All other requirements for the courses or programs as approved below must be met.

SENATE COUNCIL

THE GRADUATE SCHOOL

Graduate Center for Biomedical Engineering

Proposed: Professional Master of Biomedical Engineering

Executive Summary

The profession of engineering has two distinct but interrelated career paths: one technical and the other managerial. The University's existing Master of Science Degree in Biomedical Engineering prepares students for the former: the proposed degree program will prepare students for the latter. Previously, management and leadership skills in biomedical engineering have typically been acquired by experience in industry; however, rapid changes in technology, healthcare cost containment initiatives, and a short-term (next-quarter) corporate emphasis have rendered this process inefficient. There exists a societal need, and unmet educational market potential for, degree programs designed to educate individuals who can capitalize upon "America second gold rush" in technology. Specifically, there exists an opportunity to formally train students in engineering leadership skills to meet the emerging demands of rapidly changing, cost-conscious 21st century biomedical technology. A few leading academic institutions have already recognized this opportunity and developed this type of "professional" biomedical engineering educational program. The proposed degree program seeks to catapult the University of Kentucky into this emerging trend of graduate biomedical engineering education, compete for the nation very best students and

shape them into the technological leaders of tomorrow, while simultaneously helping to create new technologies and bring new biomedical technology-based businesses to Kentucky.

The proposed Professional Master of Biomedical Engineering degree seeks to develop a unique combination of managerial, technical, and leadership skills for those who will direct the future course of biomedical technology. The proposed program is a supplement to, not a replacement for, the existing Master of Science Degree Program in Biomedical Engineering at the University of Kentucky. This program consists of a three semester, 14-course curriculum. Eleven of these are taken from existing courses: five from Biomedical engineering, five in management and administration from the Martin School of Public Policy, and one course from the Gatton Business School. Three new Biomedical Engineering courses have been developed specifically for the proposed program. Choices and timing of these courses are specifically intended to develop the student ability to think critically and quantitatively on the multiple levels of technology, business, clinical practice, administration, science, economics, law, etc. that are required of the successful professional biomedical engineer who has chosen for his or her practice of engineering the management career alternative. The capstone course of the program, the Advanced Study Project, is an intensive student-team effort based upon a real-world biomedical technology problem that requires students to use all the skills learned in the program and provide a timely, well-studied solution.

The selection, timing, mission, and execution of the courses in the proposed program will differentiate this degree from virtually all other graduate biomedical educational programs in schools of engineering or business. The proposed program has been developed over the past several years and incorporates ideas and suggestions from a variety of faculty within the University of Kentucky as well as from leaders in industry. The initiator, author, and prime mover of the proposed program, the proposed Program Director, is an existing tenured faculty member with graduate degrees in biomedical engineering and business, as well as industrial experience in the both the bench top and the managerial career paths of the biomedical engineering profession.

The long-term goals of the proposed Professional Master of Biomedical Engineering degree are to: 1) strengthen the teaching mission of the University of Kentucky by producing top-quality graduate engineers who have leadership skills in the rapidly changing field of biomedical technology, 2) broaden the academic diversity of UK graduate biomedical engineering program, 3) enhance the national prominence of the graduate school in biomedical engineering education, 4) enhance our research mission and develop new funding opportunities for research by increasing the visibility of the University to industrial organizations, 5) enhance the number and successfulness of our biomedical engineering alumni, 6) enhance the University public service mission by offering an engineering education that has for too long been relegated to industry, 7) provide a competitive response to the professionally oriented biomedical engineering education programs that are beginning to emerge at other leading academic institutions, and 8) create or attract new upstart biomedical engineering companies within the State of Kentucky that will result from new interactions among students, faculty, and industry.

Annual costs of the proposed program are comparatively low, approximately $40,000 for the first year, decreasing annually to approximately $5,000 for fourth year. These expenses are exclusive of offsetting revenues from gifts or educational grants received specifically for the program. Excluding any grant monies or industrial contributions received for the program, it is projected that tuition payments alone will generate sufficient revenue to offset the expenses of the program and breakeven will be achieved by year five. [

Consistency with Mission

The goal of the Professional Master of Biomedical Engineering (PBME) program is to offer a professional level, practice-oriented educational program that is capable of training a new breed of engineer who prefers the management, instead of the "bench top," career route in industrial biomedical engineering. This program attempts to bridge the wide gap between the educational curriculum offered by the research-oriented Master Degree in Biomedical Engineering and the administration-oriented Masters of Business Administration programs. The Professional Master of Biomedical Engineering degree program, in conjunction with our existing research oriented program, seeks to provide highly qualified students the option of choosing an educational program that will lead them to either of two viable career alternatives. For those who seek research excellence in biomedical engineering, the current Master of Science in Biomedical Engineering is the degree of choice. However, for those who seek technical and administrative excellence in biomedical engineering, the proposed PBME program is believed to be a superior alternative to conventional management programs.

The proposed Professional Master of Biomedical Engineering is an innovative new degree program designed to teach the biomedical engineer how to manage and successfully direct rapidly evolving biomedical technologies. The long term goals of this program are to: 1) strengthen the teaching mission of the University of Kentucky by producing top-quality graduate engineers who have leadership skills in the rapidly changing field of biomedical technology, 2) broaden the academic diversity of UK graduate biomedical engineering program, 3) enhance the national prominence of the graduate school in biomedical engineering education, 4) enhance our research mission and develop new funding opportunities for research by increasing the visibility of the University to industrial organizations, 5) enhance the number and successfulness of our biomedical engineering alumni, 6) enhance the University public service mission by offering an engineering education that has for too long been relegated to industry, 7) provide a competitive response to the professionally oriented biomedical engineering education programs that are beginning to emerge at other leading academic institutions, and 8) create or attract new upstart biomedical engineering companies within the State of Kentucky that will result from new interactions among students, faculty, and industry. The new interactions among students, faculty, and industry that will occur as a result of this program offer the potential to create or attract new upstart biomedical engineering companies within the State of Kentucky.

This program is distinctive in its goals and curriculum. The 14 courses in this program are based upon specific selections of three of the 13 eligible existing biomedical engineering courses, three new courses in Biomedical Engineering (BME) developed specifically for this

program, six existing courses from the Martin School, one existing course from the Gatton College of Business and Economics and one existing course from the College of Medicine. During each of the three semesters of the program, students are exposed to advanced biomedical engineering courses, management and administration courses, and a course that links the former with the latter. The program also includes an Advanced Study Project in the final semester. The Advanced Study Project requires a team effort to use all the material learned in the program to solve an actual problem that was developed in consultation with industry. This arrangement of courses and the incorporation of the Advanced Study Project, are designed to develop the student ability to think critically, and concurrently in all of the multiple areas that comprise the professional practice of biomedical engineering. The selection and arrangement of courses, in addition to the Advanced Study Project, differentiate the proposed program from similar programs at other institutions.

This new degree program will help place the University of Kentucky at the forefront of what is becoming an important trend in biomedical engineering education. This program has the potential to catapult UK to national prominence as an innovator in biomedical engineering education and to draw upon the nation top undergraduate student population. The proposed program is consistent with UK educational mission and also has the potential to benefit its research mission through increased interaction with a wide variety of industrial organizations that will result from students' interactions with these businesses during the course of their Advanced Study Project.

External Influences

It has long been recognized that the profession of biomedical engineering has two distinct but interrelated tracks: one technical (commonly referred to as "bench top" engineering) and one managerial. Successful creation and efficient implementation of technology relies upon the successful performance of talented individuals in both of these tracks. We, as an institution of higher learning, have for too long been focused exclusively upon training engineers for the bench top career option. As an institution of higher learning, we have ignored the important educational needs of those engineers who choose to excel in their profession by selecting the management career option. Duties required of those who choose the management route include: developing corporate, product and technical goals; developing technological forecasting abilities to be in the "right" technology at the right time; clearly understanding the lifecycle of technology and providing their organizations with a blend of technologies of various maturation levels; establishing budgets and timelines; and managing teams of bench top engineers to achieve these goals.

There exists a clear need for the nation leading academic institutions to educate their students in the technological leadership skills, i.e., the "other track" in biomedical engineering. The proposed program has been planned, discussed, and refined for approximately the past five years. A wide variety of UK faculty and leaders from industry have offered suggestions and the proposed degree program reflects the best-combined effort offered by our combined talents.

Other academic institutions have also recognized this opportunity for graduate engineering education and taken the lead by implementing technology leadership programs in biomedical engineering as well as other engineering disciplines. Noteworthy examples of this include Case Western Reserve University, Rensselaer Polytechnic Institute, the University of Pennsylvania, and others (Appendix C). At the present time, the University of Kentucky would be only one of a handful of academic institutions offering this type of a degree. As a result, the University of Kentucky has the potential benefits afforded to early market entrants and the ability to achieve distinction as an institution offering a novel educational product that attracts considerable attention from students, their parents, as well as the future employers of graduates from this program. Delay in implementation of this program will result in a "me-too" status as a follower instead of a leader in biomedical engineering education.

Modern society has become increasingly dependent upon technological solutions to complex problems, especially those pertaining to healthcare. Explosive growth in new biomedical knowledge and capabilities will occur in the 21st century, but successful development and efficient implementation of these technologies will not occur in the absence of individuals with the capabilities to direct their development and implementation. The need for these individuals will increase as our ability to create new technologies grows, while our ability to chose which technologies to develop, and how to do it efficiently (so that these technologies are not the exclusive province of a few) will decrease.

The need for change is brought on by several external developments. First, the recession of the early 1990 brought a drastic change in industrial America. Gone are the days of lifetime employment and widespread long-term research efforts. Much of what now occurs in private industry is focused on the sales performance of the next quarter. Short-term thinking also predominates innovation, research, and product development. In the biomedical industry, new developments in genetic engineering, medical imaging, sensors and devices, and computer modeling of biological processes marked the beginning of a new generation of healthcare technology. Simultaneously with these technological advances came restrictions on how much resources would be spent to pay for such state of the art healthcare technology. As a result, the biomedical engineering profession struggled to balance the growing availability of new technologies with the constraints of increasingly limited resources that restricted the usage of such technologies. The rate and extent of biomedical engineering innovation is not shaped solely by technological considerations or the limits imposed by physics, chemistry, and biology, but is also constrained by federal regulations governing the safety and efficacy trials of medical devices and drugs, the growing threat of device/drug malperformance litigation, intellectual property protection and patent infringement concerns, the ability to raise funds for technology development, the rise in power of the third-party payers and their ability to promote or impede a technology based solely upon their reimbursement policies, and the emergence of the a global marketplace with a differing set of technical and clinical performance standards. In short, successful development and efficient implementation of new biomedical technology is no longer the province of the "bench top" engineer, but requires the participation of talented engineering leadership. The decade of the 1990s clearly proved the validity of the aphorism "...it more important to be in the right

technology than to do the technology right..." While the bench top engineer is trained to do the technology right, successful technology leadership requires that the biomedical engineer be directed towards the right technology that the organization should be pursuing. This is a part of the contribution to successful technological innovation made by the biomedical engineer who chooses the management route.

The advent of the Internet, and the educational opportunities afforded by this mode of communication, also offers opportunities for learning as well as threats to the role of established academia as the sole provider of formal higher learning and instruction. The professional practice of engineering provides skills needed by engineers to take ideas to the marketplace and thus create personal and societal wealth. This is a powerful motivating factor, which if not addressed by academic institutions, can become the goal of internet based "educational" organizations offering such programs, e.g. Hungry Minds.com (Appendix C). The proposed Professional Master Degree in Biomedical Engineering can also be regarded as a pre-emptive response to ensuring that education remains the province of the academic institution.

Internal Influences

The proposed Professional Master Degree in Biomedical Engineering (BME) is a response, not only to the needs of the external biomedical engineering community, but is also reflective of the career achievements and needs of our graduates. Since the formal creation of our BME program in 1988, approximately half (27 of 56) of our biomedical engineering graduates have chosen a career in industry. Most of our graduates begin their careers by doing bench top engineering, but many (an estimated 40-50% of these) will change their career focus from the bench top to the management route. While our program does well in preparing them for the former, it is lacking in preparing our students for the latter, and this is one of the motivations for the proposed Professional Master of Biomedical Engineering Degree program.

Most of UK engineering alumni, who are nominated and elected into the Hall of Distinction achieve this honor not because of their bench top engineering prowess, but because of their excellence in engineering management. It is ironic that Universities clearly recognize the value of engineers who succeed in the management route, as clearly evidenced by the awards given to such individuals, yet fail to implement the educational programs which enable these individuals to achieve the goals for which they are awarding them. Instead, engineering schools have relegated the continuing education of these "managerial" engineers to business schools or to education from within industrial organizations. Neither of these educational methods is optimal for meeting the future needs of a society in which biomedical technology, and the constraints under which such technology are developed and utilized, are changing so rapidly.

The need for, and curriculum of, the proposed program is motivated and influenced by its prime mover, the proposed Program Director, David Pienkowski, Ph.D., M.B.A., Associate Professor of Biomedical Engineering and Orthopaedic Surgery. Dr. Pienkowski has more than eight years of experience in the biomedical industry serving in both the technical and the managerial career paths. This experience, in conjunction with his MBA degree from the

Wharton School of Business, and his involvement with related programs at another institution, have aided him in shaping the proposed degree program. The proposed Program Director has maintained many of his former contacts in the biomedical industry. These relationships, along with new ones to be developed, will be invaluable in the procurement of start up funds for the program as well as to provide an ongoing supply of topics, collaboration, and experiences for students in the Advanced Study Project course. These relationships may also have longer-term benefits such as enhanced collaboration between the University existing research endeavors as well as the formation of new biomedical engineering corporate entities in the State of Kentucky.

External and internal factors have also had a key role in deciding the program name. Considerable efforts were expended to properly and descriptively name the proposed degree. Titles included for consideration were: Master of Biomedical Engineering Management, Master of Biomedical Engineering Management and Administration, Master of Biomedical Technology Management and Administration, and Professional Master of Biomedical Engineering. The first title was rejected because it appears to most as a degree focused primarily upon management and ignores the heavy emphasis upon engineering. The second was rejected because it is excessively lengthy and appears to some like it belongs in a school of business, not a school of engineering. The third name was not only lengthy but appeared to many like a program offered by a technical institute, not a university. Furthermore, all three of these names are used for similar or related programs at institutions that the University of Kentucky would not consider to be one of its peer academic institutions (e.g. St. Thomas University). The last name was selected because it reflects the practicing professionally oriented aspects of the proposed program. It is simple, different, and is consistent with the titles offered by its nearest competitors, the Professional Master Degree of Biomedical Engineering recently offered by Rensselaer Polytechnic Institute and the University of Pennsylvania. This latter point is considered especially important for readily communicating the identity and goals of the program and to enhance the marketability of the proposed program to prospective candidates.

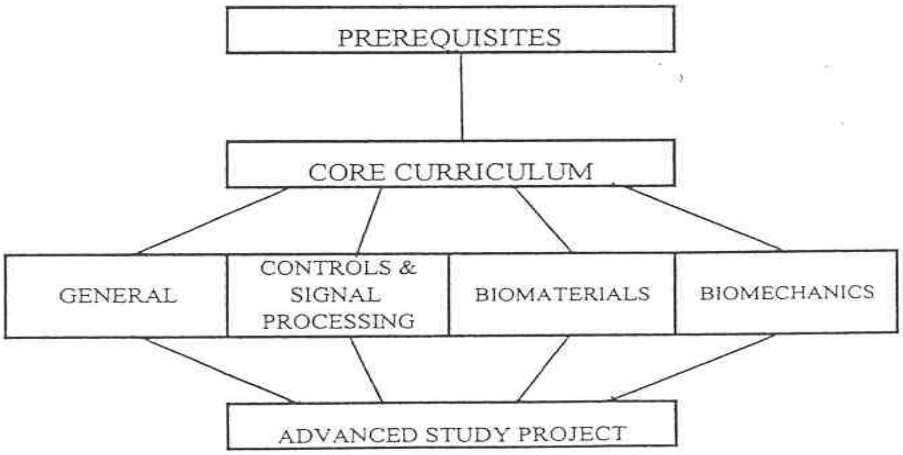
Relationship to University Organizational Structure

The proposed Professional Master of Biomedical Engineering Degree will be based at the Graduate Center for Biomedical Engineering. The Center currently offers the Master of Science and Doctor of Philosophy Degrees in Biomedical Engineering. It is located administratively under the Office of the Chancellor of the Medical Center (Figures 1 and 2). The Director of the Center reports to the Dean of the Graduate School who in turn, reports to the Chancellor of the Medical Center. There are currently nine tenure-track faculty appointments in the Center. As mentioned earlier, the Director of the proposed program will be Dr. David Pienkowski who is a full time tenured faculty member in the Center. In addition to his graduate degree in Biomedical engineering, he also has an MBA degree in Management from the Wharton School and has more than eight years experience working full time in the biomedical industry. He will guide the direction of the new program and will be primary supervisor of the students.

Curriculum

Educational components of the curriculum of the proposed Professional Master of Biomedical Engineering Degree are shown in the following schematic diagram. The program begins with a set of prerequisite courses designed to ensure that all entering students (each with an engineering background) have a common basis of knowledge. A core curriculum in the sciences, engineering, and business related courses is presented as a foundation for more advance work in specialized areas of biomedical engineering such as signals and control systems, biomaterials, and biomechanics. A general curriculum was created for students who seek competence in a wide variety of biomedical engineering pursuits preparatory to a career as a management or technology consultant, venture capital associate, or industry analyst.

PROFESSIONAL MASTER DEGREE IN BIOMEDICAL ENGINEERING
Schematic Illustration of Degree Components and Sequences



The curriculum of the proposed Professional Master of Biomedical Engineering is unique because it is designed to develop critical thinking and quantitative analytical skills on both the biomedical engineering and management levels, and to do this concurrently over a wide variety of subjects that influence the development of biomedical technology. Simultaneously, the program seeks to develop the students competency in the quantitative Advanced Study Projects of biomedical engineering management and administration fundamentals, e.g., managing technical people, marketing of medical devices and drugs, constraints on technology development and implementation due to patent concerns, ethical considerations, reimbursement policies, government safety and efficacy regulations, clinical practice and usage, etc. Options to pursue various subspecialty areas of biomedical engineering (see Appendix B - attached) allow the students to advance their knowledge of a variety of biomedical engineering sub-disciplines (e.g., biofluids, biomaterials, biosignals and controls, and biomechanics). Flexibility in the business component of the curriculum allows students to concentrate on either management or finance, depending upon their career goals.

Bridge courses in each semester link the biomedical engineering components of the program to the management and administration components. These bridge courses, e.g., BME 642:

Constraints in Biomedical Engineering (ethics, patent law for biomedical engineers, medical device regulations, etc.), HA 601: Healthcare System Overview, and BME 767: Management of Technology, emulate important real-world relationships between the technical opportunities and limitations inherent in the fundamental science of the technology and the constraints and opportunities posed by the administrative aspects of biomedical engineering.

The engineering component of the proposed curriculum is only one or two courses less than the course work required for the existing research-oriented Master of Science Degree in Biomedical Engineering. However, instead of performing a thesis-based research project, the Advanced Study Project associated with the proposed degree requires in-depth use of the student newly acquired skills to prepare, or properly critique (as in a venture capital related due-diligence analysis) a business plan for the development of a new medical device or technology. The written component of the Advanced Study Project will be completed by a group effort of three-to-five students and it will reflect the level of effort needed to write an actual business plan, industry analysis, or due-diligence analysis of an emerging medical device or a new biomedical technology.

Didactic Clinical Relationship

An important educational component of the proposed new Master Program in Biomedical Engineering is the summer internship /Advanced Study Project experience. This segment of the program is designed to help the students implement much of their newly gained knowledge by working with a variety of outside organizations, e.g., a venture capital firm, a manufacturer of medical devices, a technology analyst group of a brokerage house, etc. to perform a needed real-world assessment of an existing or emerging technology or to quantitatively forecast the rate of technological change in a specific field of endeavor, etc. The Program Director will consult with groups of students regarding the selection of the Advanced Study Project. These consultations will occur during the later portion of the Fall semester of the first year of the students program. Students will work on and present their Advance Study Project in a team setting only. Since the Advanced Study Project will be based upon one of several existing "real world industry based problems," participation of the students at the sponsoring organizations facilities is strongly recommended as part of their performance on the Advanced Study Project. Students will be expected to gain first hand knowledge regarding the participating organization business and develop a working relationship with the personnel of this organization to formulate the problem, develop a method of attack, solve the problem, and devise a plan for solution implementation. The Advanced Study Project will culminate in the preparation of both a formal written report (which will be provided to the participating organization) as well as an oral presentation delivered on campus via a special one-day biomedical engineering forum to which all engineering students are invited. This report will describe in detail the assessment of a technology, present a business plan and describe the strategy for an R & D effort, etc. and how it was needed and used by the participating organization. The evaluation of the Advanced Study Project will be conducted with the same rigor and according to the same rules as are ordinarily applied to the final examination process of students pursuing a traditional masters degree in engineering.

One of the existing Advanced Study Projects that await student involvement concerns the need to develop a strategic plan for a major manufacturer of orthopaedic implant devices. This manufacturer seeks to develop a succession of new products in the field of tissue engineering. The students would be required to travel to the manufacturers place of business, obtain information about the company existing business (history, philosophy, product lines, technical competencies, equipment and physical plant, etc.), perform a technological assessment of the need and market potential (based upon demographic and economic changes) for new materials replacing worn or diseased bone and cartilage, make an assessment of the current state of the technology as well as its direction and rate of change, etc. This information would be assimilated by the students (using the materials learned in the program) and formally delivered in a written plan and then presented orally to the faculty, the sponsor and its representatives, and other students in the program. The sponsor would benefit from a plan for developing a viable stream of new innovations in the field of tissue engineering that is consistent with its corporate mission and capabilities.

It is expected that initially only partial support for this effort will be obtained from the sponsoring extramural organization, but as the success of the program develops, it is expected that all of the support for the Advanced Study Project portion of the proposed program will be received from extramural sources.

The student faculty ratio for the didactic component of the program is estimated to be 15-20 students per faculty member, while the student faculty ratio for the Advanced Study Project is estimated to be five students per faculty member.

There are few opportunities for students of the program to actively engage in an Advanced Study Project with companies that are presently located in Kentucky (except for MedVenture, Inc. in Louisville, KY). It is likely that for the conceivable future of the program most students will be required to travel out of state and work with a manufacturer (e.g., Ethicon, Inc. in Cincinnati, OH, DePuy Orthopaedics, Inc. in Warsaw, IN; Smith and Nephew Richards, Inc. in Memphis, TN), a venture capital or brokerage house firm (Viscogliosi Brothers, Inc., in New York, NY or SenMed Ventures, Inc. in Cincinnati, OH) or a small upstart manufacturer (typically located in the "medical alley" regions of Minneapolis, MN or San Diego, CA) to accomplish their Advanced Study Project. The Director of the Program will create the opportunities for student involvement with the Advanced Study Projects. Although several project opportunities already exist, the subject of and need for these opportunities continues to change. Identification, cultivation, establishment of industrial liaisons which lead to such projects will require a substantial effort in the first year or two of the program, but the effort required will decrease as the program, and its results, become known and appreciated. That is, industrial concerns will also come to the program seeking help and offering opportunity. Furthermore, the project choices available to the students will increase as a result of anticipated growth of the biomedical industry in Kentucky.

<u>Accreditation/Certification</u>

As with most graduate programs in traditional engineering and biomedical engineering, accreditation is neither sought nor considered necessary. Therefore, accreditation will not be sought for the proposed program.

It is important to note that use of the term "professional" in the name of this degree program is done for the purpose of curriculum differentiation from other graduate engineering programs, but does not confer to students in, or graduates of, this program the same rights and privileges granted by the State of Kentucky to those who successfully pass any of the examinations for professional engineering licensure.

Admission Criteria/Standards/Procedures

For the first three years of this new program, applicants will be considered who: 1) are graduates of accredited undergraduate biomedical engineering programs (and in special circumstances, other undergraduate engineering majors), 2) who have high grade point averages (GPA of 3.2 or greater), and 3) have competitive Graduate Record Examination (and possibly, equally competitive Graduate Management Aptitude Test) scores. In the event of applicants with equivalent objective credentials, preference will be given to those with promising prior work experience or those with exceptional letters of recommendation.

In addition to the customary University of Kentucky graduate admissions procedures, admission to the program will require students to complete an essay on their career aspirations and why the completion of the proposed program will help them reach these goals, as well as other essay questions designed to identify applicants with exceptional critical thinking and communication skills. All applications will be screened by the Program Director. Acceptance or rejection of each candidate will be determined by an admissions committee composed of faculty from the Center for Biomedical Engineering, and the Martin School of Public Policy and Administration.

Recruiting for PBME students will begin as soon as possible with a start date of Fall 2002 if this proposal is approved. Applications for the program will be accepted in the Spring semester and will continue until the class size targets have been achieved. Decisions will be made regarding admission beginning March 1. Applicants lacking the needed prerequisite course work may be accepted on a conditional basis, pending satisfactory completion of the prerequisite courses. Invited candidates will be notified by telephone, email, and first class mail.

Student enrollment in the first few years of the program will be encouraged by full or partial tuition assistance, depending upon program funding resources. Students in traditional engineering departments will also be recruited provided that they have also fulfilled the required prerequisites. At this time, all students must be required to take the courses listed in the program and no students will be excused from any of these courses based upon prior course work, unless these courses were taken at the University of Kentucky within two years prior to admission to the program. There are no provisions for advanced placement at this time.

It is anticipated that approximately five students will enroll in the first year of this program, and seven in the second year (Table 1A, Appendix D). The entering class size will grow by two and three students, respectively, for each of the next two years of the program (years three and four). Beginning with the fifth year of the program, the entering class size will expand to an estimated 13 students. These projections will result in a total class size (both years of the program) of approximately 30 students. At the present time, it is expected that the total class size will remain at this (30 students total) level pending future review and analysis of the program.

Evaluation of the Students

The objective of the Professional Master of Biomedical Engineering educational program is to prepare students for a professional level, practice-oriented career in the technical and managerial aspects of the biomedical engineering industry. The curriculum of this program attempts to develop in the student the ability to analyze real problems from the wide variety of perspectives required of professional managers of biomedical engineering technology. All of the courses listed in the proposed curriculum are essential components of developing the intended critical thinking and analytical skills that the program is designed to teach. Specific examples of the various subspecialty areas of study are shown in Appendix B. Simultaneous use of these skills will be put to the test during the last semester when the Advanced Study Project requires the solution of an actual problem.

All Biomedical Engineering faculty will evaluate course-related performance of individual students during the normal biannual student review session conducted by the Center for Biomedical Engineering. For their Advanced Study Project, the performance of each group of students will be graded as an entity by the Program Director. This grading process will also be assisted by the recommendations of personnel from the organization with whom the students have worked. Individual performance of the students within their group will also be evaluated by their teammates, in addition to the Program Director and the personnel from the collaborating organization. This evaluation process will be conducted with the same rigor and analogous rules that are applied to the final examinations that are administered to graduate students pursuing a traditional master of engineering degree at the University of Kentucky.

Evaluation of the Program

To be evaluated after the 2006-07 academic year by a committee appointed by the Dean of the Graduate School according to the following criteria.

1) GPA, GRE (and GMAT) scores or percentiles of the entering candidates: (and will compare these values to entering candidates in other graduate and professional programs in UK, its peer schools, and nationally),
2) number of applications per class position,
3) perceived value of the program to industry as measured by the:
   - dollars of industry support contributed to the program,

- number of firms participating in the advanced study projects,
- number of job offers and starting salaries offered to program graduates,

4) percentages of graduates receiving favorable reviews from their employers one year after beginning work,
5) evaluations from graduates of the program who have worked for two or more years in the practice of biomedical engineering, and
6) number of start-up commercial enterprises in the State of Kentucky that are attributable to the Professional Master of Biomedical Engineering Program.

Advisory Committee

The following Internal Advisory committee at the University of Kentucky has developed the proposed Master program:

David Pienkowski, Associate Professor of Biomedical Engineering and proposed Program Director
Charles Knapp, Director, Center for Biomedical Engineering
Thomas Lester, Dean, Engineering School
Gina Toma, Dean, Martin School of Public Policy and Administration
Faculty, Center for Biomedical Engineering

Subsequent to the implementation of this new degree, an external advisory committee will be formed to guide the continuing development of this program and to assist the internal advisory committee members. Although no external advisory members have been formally invited to participate in the proposed program, potential candidates for this committee include:

Dr. Jonathan Black, Principal, IMN Biomaterials, King of Prussia, PA
Ms. Elaine Duncan, Principal, Paladin Medical, Sweetwater, MN
Mr. Richard Tarr, Director of Research in Orthopaedics and Orthobiologics, DePuy Orthopaedics, Inc., Warsaw, IN
Dr. Robert J. Morff, Associate Director, Medical Technology, Senmed Medical Ventures, Cincinnati, OH
Mr. Kevin Bramer, President, MedVenture, Louisville, KY
Dr. Foster B. Stulen, Manager, External Ventures, Ethicon Endo-Surgery Cincinnati, OH

Plans for Articulation/Transfer/Cooperation

This program will be complementary to the University existing Master of Science Degree program in Biomedical Engineering. It will also interact with the Master of Public Policy and Administration Program at the Martin School through the sharing of classes. Students in the program will also take one course (MKT 600) from the Gatton School of Business and

Economics and one course from the Medical School (PGY 412G). Physiology is required of all graduate biomedical engineering students regardless of whether they choose the existing traditional degree or the proposed new degree program. All applications will be screened by the Program Director. Acceptance or rejection of each candidate will be determined by an admissions committee composed of a small group of faculty from the College of Engineering, the Center for Biomedical Engineering, and the Martin School of Public Policy and Administration.

The proposed program will recruit top quality students from within the State of Kentucky as well as nationwide. Given the level of effort that will be needed to develop this program, no relationships with other academic institutions are foreseen at this time during the early developmental years of this program.

All students will be considered for admission to the program solely upon the basis of undergraduate grades, letters of recommendation, objective test criteria (i.e. Graduate Record Examination and possibly the Graduate Management Aptitude Test), and prior professional experience. Current students (or recent graduates) of the University of Kentucky, who satisfy the prerequisites for admission, will be considered on an equal basis with all other applicants for admission to the program.

Due to the almost unique nature of the program, there are no plans at present for mid-program student transfers.

Personnel Requirements

The following is a summary of the personnel requirements to implement this program. Since the program has been developed around curricula already in place and operational at the University of Kentucky, additional personnel needs are minimal. These requirements consist of: 1) Program Director (David Pienkowski, full-time tenured faculty member in the Center for Biomedical Engineering, estimated 50% effort), 2) one-part time (initially) administrative assistant (to be hired), and 3) three part-time visiting faculty.

The proposed program appears to require much of the time and efforts of the proposed program director for: 1) promotion and marketing of the program, 2) recruitment and selection of students, 3) developing materials for and teaching the three new Biomedical engineering courses (BME 642, BME 767, BME 777), as well as revising this evolving curriculum, and 4) seeking external funding for support of this program. Promotion and marketing of this program will be done by a professionally created website and banners, advertisements in selected journals, and other advertising vehicles frequented by outstanding potential students. Thus, the promotion and marketing of this program will not depend upon the program director as much as some might expect. Similarly, interviewing and selection of candidates for the program will not depend heavily upon the proposed program director, but will be done by a committee of faculty from the Center for Biomedical Engineering, the Martin School of Public Policy, and the Gatton School of Business. Course materials for BME 642 have largely been developed, and this course will be taught by three (possibly four) visiting faculty. Only BME 767 will require new course development by the

proposed program director (there are no other faculty on campus who can teach this course). The workload for BME 777 will be distributed among other faculty, as well as industry representatives working with the faculty, all of whom will be participating under the supervision of the program director. If these time allocations prove inadequate, then the proposed program director will consider reallocation of his other responsibilities to provide the time needed to successfully direct the proposed Professional Master of Biomedical Engineering Program.

It is anticipated that the administrative assistant will only be needed on a 50% full time equivalent basis during the first year of the program. Other tasks, e.g., application forms receipt and processing, applicant interview arrangements, etc., will be performed by existing Center for Biomedical Engineering administrative personnel. The anticipated growth of the program will require an increase of 20% more time of this administrative assistant each year of the program until, by approximately year five of the program, the administrative assistant will be needed on a full-time basis. Additional tasks required of the administrative assistant for year five and following would be cost allocated on an as needed FTE equivalent fractional basis. Much of the administrative assistant time will be needed for coordinating the campus trips of the visiting faculty, ordering supplies and educational materials, and interacting with the organizations which sponsor the Advanced Study Projects.

Each of the visiting faculty members is needed to teach the equivalent of a 1-credit course in his or her field of expertise (patent law for engineers, standards and government regulation of drugs and medical devices, and ethics in biomedical engineering). The intended visiting faculty in consultation with the proposed program director has developed preliminary curricula for these courses. These curricula have been presented to biomedical engineering students on a trial-basis, and preliminary results indicate wide student acceptance of the material. Formalized incorporation of these course materials into BME 642 awaits approval of the proposed Professional Master of Biomedical Engineering Degree program.

Similar Programs in Kentucky

There are no programs in Kentucky that are similar to the one being proposed. In fact, there are only two other known programs outside Kentucky that have implemented a program in Graduate Biomedical Engineering education similar to that proposed. See Section entitled Comparable Programs in Other State below for additional details.

Comparable Programs in Other States

Professional engineering education programs have begun to emerge at other academic institutions. These programs are a response to the growing recognition that engineers create as well as bring to market invaluable new technologies upon which society has increasing reliance. The involvement of engineers in the commercialization of technology, increasing societal dependence upon and financial rewards for technology and technological innovation have fueled the need for formal academic programs that that offer training and experience in managerial as well as technical engineering related subjects. Recently, such professionally oriented engineering educational programs have emerged at the following academic institutions:

Case Western Reserve University
Dartmouth University
Penn State University
Rensselaer Polytechnic Institute (offers Professional MS in BME)
Syracuse University
St. Thomas University
University of Illinois at Chicago
University of Pennsylvania (offers Professional MS in BME)

While all of these institutions offer professional graduate education programs in traditional engineering disciplines, only Rensselaer Polytechnic Institute and University of Pennsylvania have professional graduate biomedical engineering educational programs. Specific information based upon their website published materials, is contained in Appendix C.

The concept of professionally oriented degrees in other disciplines (distinct from medicine, law, dentistry, etc.) is also beginning to emerge at other universities. Washington University in St. Louis has recently instituted a Professional Master of Business Administration degree program. This program claims to provide their graduates with better preparation for the practice of business than traditional MBA programs (Appendix C available upon request).

Student Demand

While it is difficult to gauge the student demand for a program that is not widely known, two observations suggest that the prospective student population will eagerly receive the program. First, admission opportunities to similar or related programs at other institutions have been oversubscribed. Admission to these programs is limited by class size and is very competitive. The fact that competition for admission to these programs is substantial (and becoming more so with time as the popularity of the program, and its effect on the career of the graduates, becomes known) suggests that the program, once advertised, will attract a significant number of students. Second, casual mention of the program and its intended goals to several students, faculty, and employers, as was done during the development of this program, has also been met with considerable enthusiasm. The enthusiasm shown by students for programs of similar names at other institutions is a motivating reason for adopting the name "Professional Master of Biomedical Engineering" for the proposed degree program.

As stated earlier, it is anticipated that approximately five students will enroll in the first year of this program, and seven in the second year (Appendix D available upon request). The entering class size will grow by two and three students, respectively, for each of the next two years of the program (years three and four). Beginning with the fifth year of the program, the entering class size will expand to an estimated 13 students. These projections will result in a total program enrollment (both years of the program) of approximately 30 students. At the present time, it is expected that the total enrollment will remain at this (30 students total) level pending future review and analysis of the program.

Evaluation of Related Programs

While the proposed Professional Master of Biomedical Engineering shares courses of existing graduate biomedical engineering, public policy and administration, and business educational curriculums, it does not overlap as a degree entity with any other existing degree programs at the University of Kentucky. The proposed degree creates a new degree entity by a careful selection and arrangement of existing courses in these programs, plus three new courses developed specifically for the proposed program.

Anticipated Issues/Trends

Several trends have emerged which place the proposed Professional Master of Biomedical Engineering in a favorable light. As noted earlier, societal reliance upon technology has created an increasing demand for engineers. As a profession, engineers create value for society and this value is slowly, but inexorably, becoming recognized and rewarded. Particular rewards are being offered to those who steer their organization towards "...the right technology," and it is in this spirit that the Professional Master Degree Program in Biomedical Engineering intends to educate its students.

The growing rewards offered to managers of technology, coupled with the decline in income and status of the health and legal professions has increased the desirability of the program to the best and brightest who would otherwise seek a career in medicine and law. This has been the experience of the program at the University of Pennsylvania. Growth in its program is limited by faculty size and time commitment to the effort, not by lack of student interest in the program.

Thus, it is anticipated that as the attractiveness of careers in biomedical technology continues, while simultaneously the attractiveness of careers in medicine and law decreases, the interest in engineering management oriented programs like that proposed will increase. If the program is marketed and conducted properly, it is conceivable that this program could have a 10 to 1 applicant/admission ratio and thus it could become one of the leading academic and income producing graduate programs of the University of Kentucky.

Resources Required

Resources required to implement this program consist of modest reassignment of one faculty member distribution of effort (the Program Director) and the hiring of a half-time (initially) administrative assistant. Proposals for the remaining three courses in the curriculum of this program may be found on pp 20-21. Dr. Chalres Knapp, Director of the Center for Biomedical Engineering, has confirmed the reallocation of Dr. Piekowski's academic time so that he can direct and teach in the Professional Master's Degree Program, beginning Fall, 2002.

Relatively minor expenditures are needed for new teaching materials, program advertising, and visiting faculty expenses. Otherwise, no major alterations to any program are required, nor are there any substantial capital equipment or building renovation/construction requirements.

Expenditures

This is an inexpensive program to implement. Summarized program expenditure estimates are presented in Table 2 (Appendix D available upon request) and are justified below. Most of the modest expenses required derive from a half-time executive administrative assistant, expenses for three visiting faculty, and program advertising expenses, and other minor miscellaneous expenses. The budget (available upon request), and accompanying budget justification, lists these expenses and their need in detail.

An administrative assistant will be needed at the outset of the program to help with the review of applicants, maintain contact lists of inquiring students and their parents, procure educational materials for this curriculum, and orchestrate the orderly visitation of the visiting faculty needed for teaching BME 642. This person will also participate in maintaining records and correspondence with all private sector contacts (actual or potential sources of BME 777 projects), facilitating visits by representatives from these organizations, and assisting the Program Director in procuring financial support for the program as well as assistance with the recruitment of subjects and sponsors for the students Advanced Study Projects. Initially, it is estimated that this person will only be needed on a 50% FTE basis, but this need will grow at an estimated 20% per year until year four when it is anticipated that the need will be for a full time (100% FTE) administrative assistant.

Three visiting faculty members will be needed to teach the content of BME 642. Costs associated with these faculty are minimal and their educational materials have already been developed and presented to students at UK and other institutions. The first of these visiting faculty members will be Mr. Sam Smith, J.D., a retired patent attorney with experience in government and the private sector. He will teach the first one-third of BME 642. Mr. Smith and the Program Director have already developed the curriculum for this component of the course, and this material has already been presented to BME students on a trial basis during the BME 772 seminar series. Highly favorable student evaluations were received regarding the lectures accompanying this curriculum. Mr. Smith is a Lexington resident who is enthusiastically committed to teaching this material in the proposed PBME program. His participation in the teaching effort will require only an honorarium. No travel or housing expenses will be needed.

The second visiting faculty member will be P. Elaine Duncan. Ms. Duncan is a graduate of UK program in Mechanical Engineering and she has considerable experience in the medical device industry. For the last 12 years, Ms. Duncan has been the founder and President of Paladin Medical, Inc., a private consulting group providing advice regarding quality assurance, standards compliance, and regulatory affairs to small- and medium- sized companies in the medical products industry. Ms. Duncan is also a 2000 inductee into the UK Engineering Alumni Hall of Distinction. For the last five years, Ms. Duncan has regularly lectured to UK biomedical engineering students. Her topics have covered the role of standards and government regulations on the engineering constraints and design implications of medical devices. Her family lives in Lawrenceburg, KY and she regularly travels to Kentucky to visit them throughout the year. Ms. Duncan will require modest travel support and an honorarium, but no housing expenses are anticipated.

The third visiting faculty member will be John Fielder, Ph.D. Dr. Fielder is Professor of Philosophy at Villanova University and is known nationwide for his long involvement in the study of ethics in engineering. Representatives from the biomedical industry and the Food and Drug Administration (FDA) regularly consult Dr. Fielder regarding ethical issues in drug and medical device development. Dr. Fielder has also developed several well-researched case studies involving a variety engineering efforts including the Shiley heart valve, the DC-10 airframe, and the Brooklyn Bridge. He also has a video teaching series that will supplement his on-campus lectures. Dr. Fielder will require airfare, housing, meals, and honoraria payments ($500 per day) for his contributions to the teaching of BME 642.

The PBME program must be publicized if it is to succeed in its goal of attracting adequate numbers of the best and brightest future leaders and shapers of biomedical technological innovation. To do this, considerable advertising efforts must be expended to make potential customers aware of its existence and how it can jumpstart their careers. Owing to the computer literacy of contemporary undergraduates and the pervasive influence of the internet, most of the promotional expenses incurred with advertising the program will be focused upon developing an informative, attractive, well-linked website that provides information about the program and what it can do for the potential applicant career. Most of these expenses will be incurred in the initial years of the program, and only modest funds will be requested as the program continues for refinement of the initial efforts and refocusing of the website based upon student evaluation and feedback. The website will be designed, researched, and implemented by In Situ, Inc., a Lexington-based company. The Program Director has considerable experience with In Situ Inc. website development and has worked with the principals of this organization to develop other websites. He will actively participate in the design and implementation of this degree-program promotional website and is confident that In Situ Inc. can provide an effective recruiting and promotional tool that is so essential to the success of the PBME program.

Modest additional funds are requested for the development of posters (to be displayed outside undergraduate Biomedical Engineering administrative offices at institutions in the US and Canada. Brochures will also be prepared for mailing to undergraduate biomedical engineering students, as well as for distribution at conferences attended by prospective students. It is anticipated that the program director will personally meet and recruit highly qualified applicants to the program. Specifically, he will travel to nearby academic institutions (Vanderbilt University, Purdue University, University of Cincinnati, etc.) to speak to undergraduate students regarding new career opportunities that will become available to graduates of the PBME program.

Sources of Revenue

Most of the revenue derived from the PBME program will come from tuition paid by students. Estimates of the number of new students entering the program in each year of the program existence are shown in Table 1A (Appendix D available upon request). Based upon these estimates, and assumptions that all students in the program will be considered Kentucky residents, projected program income from tuition is shown in Table 3 (Appendix D available upon request). The resident assumption is abased upon the criteria that entering

graduate students with an undergraduate GPA of 3.25 or higher are afforded resident status tuition, the minimum GPA required by the program (3.2) and the hope that most of the entering students will have GPAs considerably higher than 3.2. The upper and lower enrollment estimates, as well as revenue estimates, are labeled "high" and "low" in these tables.

The Program Director will also seek additional sources of revenue from government agency grants and private sector donations to offset the negative cash flows that accompany the initial years of the program. Due to the sporadic, likely nonrecurring, and uncertain nature of these contributions, no revenue contributions to the program are shown in Tables 1 – 4 (Appendix D is available upon request). Table 4 summarizes the net cash flows (program revenues less expenditures) generated by this program, given the previously stated assumptions.

It is worth noting that, based upon conservative estimates of student enrollment and tuition growth, this program offers the opportunity to generate considerable excesses of revenue over expenses (Table 4, Appendix D is available upon request). Thus the Professional Masters Degree in Biomedical Engineering has the potential to be a substantial revenue (profit) generator for the University of Kentucky.

Sample curricula of the Proposed Professional Master Degree in Biomedical Engineering (presented in general and track-specific configurations) are attached.

Tables 1 - 4
Spreadsheet files listing projected annual: Student Enrollments, Expenditures, Revenues, and Net Revenues accompanying the Proposed Professional Master Degree in Biomedical Engineering are available upon request

New Courses

BME 642 Navigational Guides for Biomedical Product Development (3)
This course teaches engineers how biomedical product designs are influenced by government regulations, economic issues, and ethical concerns.

BME 767 Management of Technology (3)
Successfulness in developing new technologies relies upon knowing which technology advance, the ultimate scientific limits of that technology, and the forecasted rate of technological change. This course presents curricula that explore the direction of technological change and how this affects the rate and extent of innovation.

BME 777 Advanced Study Project (3)
This is an independent study project, topic to be selected in consultation with the instructor. Purpose is to integrate all materials learned in the program

and apply these principles to the solution of an actual problem in biomedical engineering technology.
Prerequisites: Permission of instructor and completion of year 1 PBME studies

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3.3.1 REMOVAL OF COURSES FROM BULLETIN: PURGING COURSES [RC: 11/14/88]

If a course has not been taught in the classroom, by extension or correspondence, within a four-year period, the Registrar shall remove the description of the course from the University *Bulletin*. A course so removed from the *Bulletin* shall remain in the University course file for an additional four years (unless the college requests its removal). During the additional four year period, the college may offer the course and, if it is taught, the Registrar shall restore its description to the University *Bulletin*. If it is not taught within the four year period, the course shall be removed from the University course file. (US: 2/10/86)

In accordance with University Senate Rules, Section III - 3.3.1 (above), the following courses are being reinstated into the 2002-2003 *Bulletin* because they have been taught.

ANT 543
ANT 640
AST 395
BIO 553
CHE 646
CS 587
SPI 241
SPI 612
SPI 622
SPI 643
HDI 600
HDI 602
HDI 603
HIS 120
HIS 633
RAS 849
SOC 640
EE 587
EE 604
ENG 630
FIN 691

In accordance with University Senate Rules, Section III - 3.3.1 (above), the following courses are being purged from the *Bulletin* because they have not been taught for four years.

AEC 312
AEC 315
AEC 502
ANA 513
ANT 425
ANT 664
ARC 721
ARC 722
ARC 728
ARC 750
B&E 100
BIO 563
BIO 614
BIO 707
BSC 664
BSC 778
BUS 519
BUS 556
CD 555
CE 103
CE 199
CJT 650
CJT 615
CJT 715
CJT 721
CJT 745
CJT 782
CLA 425G
CLS 815

CS 223
CS 480G
ECO 463
ENG 369
ENG 439G
ENG 726
ENT 563
EPE 650
FAM 689
FAM 693
FOR 663
FR 501
GEO 256
GEO 508
GEO 718
HIS 655
MNG 634
MNG 641
MSC 106
MSC 108
MSC 205
MSC 301
MSE 550
MUS 140
NUR 663
NUR 683
NUR 715
NUR 716
NUR 717
NUR 741
NUR 742
NUR 743
NUR 744
PGY 607
PHI 570
PHR 395
PHR 831
PHR 835
PHR 850
PHR 890
PHY 140
PS 412G
PS 427G
PS 571
PS 630
PS 760
PS 770
PSY 425
PSY 664
RAS 715
SOC 425
SPI 296
SPI 326
SW 604

In accordance with University Senate Rules, Section III - 3.3.1 (above), the following courses are being removed from the University course inventory because they have not been taught in eight years:

ACC 611	PROFESSIONAL ISSUES IN ACCOUNTING
ACC 701	SEMINAR IN FINANCIAL ACCOUNTING
ANA 396	CURRENT TOPICS IN NEUROBIOLOGY
ANA 815	FIRST-YEAR ELECTIVE, ANATOMY
ANA 825	SECOND-YEAR ELECTIVE, ANATOMY
BCH 815	FIRST-YEAR ELECTIVE, BIOCHEMISTRY
BIO 261	FIELD BOTANY
BIO 585	PATHOGENIC MICROBIOLOGY
BIO 586	PATHOGENIC MICROBIOLOGY
BME 630	MAGNETIC RESONANCE IN BIOMEDICINE
BME 650	MUSCULOSKELETAL BIODYNAMICS
BME 680	ADVANCED TOPICS IN ORTHOPAEDIC BIOMECHANICS
BME 682	ADVANCED TOPICS IN BIOMECHANICS
BSC 815	FIRST-YEAR ELECTIVE, BEHAVIORAL SCIENCE

BSC 851	RESEARCH IN BEHAVIORAL SCIENCE
BUS 118	,ADVANCED KEYBOARDING AND WORD PROCESSING
CD 589	CRANIOFACIAL ANOMALIES
CD 592	PROBLEMS AND NEEDS OF THE HEARING IMPAIRED
CD 702	SEMINAR IN SPEECH PATHOLOGY (VARIABLE TOPIC)
CDS 770	GERIATRIC DENTISTRY SEMINAR - CLINIC
CDS 790	RESEARCH IN GERIATRICS
CE 636	OPERATIONAL EFFECTS OF GEOMETRICS IN TRANSPORTATION
CLA 530	THE TEACHING OF LATIN
CLA 562	STUDIES IN GREEK PHILOLOGY
CLS 817	HISTOTECHNOLOGY III
CON 841	AMBULATORY MEDICINE
DIS 650	DATA ANALYSIS FOR DECISIONS
DIS 760	RESEARCH METHODS IN DECISION SYSTEMS
EDA 608	INTERNSHIP IN EDUCATIONAL ADMINISTRATION AND SUPERVISION
EDC 325	TEACHING IN THE ELEMENTARY SCHOOL
EDC 500	CLINICAL AND LABORATORY TEACHING
EDP 762	ORGANIZATION AND OPERATION OF PUPIL SERVICES
EDV 588	HOME ECONOMICS EDUCATION PROGRAMS
EDV 685	HOME ECONOMICS CURRICULUM CONSTRUCTION
EE 607	ELECTRIC MACHINE DESIGN
EE 614	SAMPLED-DATA CONTROL SYSTEMS
EE 660	ELECTRONIC DEVICE DESIGN
EE 664	SAW DEVICE DESIGN, MODELING, AND APPLICATIONS
EM 510	DYNAMICS AND DESIGN OF ROBOT MANIPULATORS
ENG 472G	SPECIAL TOPICS IN FOLKLORE: (SUBTITLE REQUIRED)
ENG 673	STUDIES IN FOLKLORE
ER 815	FIRST-YEAR ELECTIVE, EMERGENCY MEDICINE
FOR 405	MECHANICS AND PHYSICS OF WOOD
FP 815	FIRST-YEAR ELECTIVE, FAMILY PRACTICE
FR 200	ORAL PRACTICE IN FRENCH III
FR 502	FRENCH LITERATURE AND THE ARTS: LA BELLE EPOQUE
GLY 511	PETROLEUM GEOLOGY
GLY 571	APPLICATION OF POTENTIAL METHODS IN APPLIED GEOPHYSICS
GLY 572	EXPLORATION SEISMOLOGY
HES 786	ADVANCED PROBLEMS IN HUMAN ENVIRONMENTAL SCIENCES
HIS 331	A HISTORY OF WESTERN RELIGIOUS THOUGHT (II)
HIS 354	TOPICS IN NON-WESTERN HISTORY BEFORE 1789
HIS 516	ORIGINS OF THE SCIENTIFIC WORLD VIEW
HIS 522	THE FRENCH AND EUROPEAN REVOLUTIONS, 1760-1815
HIS 552	BRITISH SOCIAL HISTORY DURING THE TUDOR-STUART PERIOD
HIS 583	SCIENCE IN AMERICAN SOCIETY
HSE 320	PROFESSIONAL HEALTH EDUCATION METHODOLOGY
HSE 340	WOMEN, HEALTH AND HEALING
HSE 670	ADVANCED SEMINAR IN ALLIED HEALTH
HSE 690	RESEARCH PROBLEMS IN ALLIED HEALTH
HSM 538	FINANCIAL MANAGEMENT TECHNIQUES FOR THE CLINICAL MANAGER
LAW 812	CONTRACTS
LAW 867	TAX PRACTICE AND PROCEDURE
LAW 870	MINERAL LAW

LAW 873	LAND TRANSFER LAW
LAW 879	COMMERCIAL LAW I
LAW 883	BUSINESS BANKRUPTCY
MA 615	CONVEX ANALYSIS AND OPTIMIZATION
MA 631	MATHEMATICAL FOUNDATIONS OF STOCHASTIC PROCESSES AND CONTROL THEORY II
MA 678	MATHEMATICAL THEORY OF OPTIMAL CONTROL
MD 831	INTEGRATIVE COLLOQUIUM
MD 850	INTEGRATIVE STUDIES
ME 510	DYNAMICS AND DESIGN OF ROBOT MANIPULATORS
MED 815	FIRST-YEAR ELECTIVE, MEDICINE
MED 835	THIRD YEAR ELECTIVE, MEDICINE
MED 871	CLINICAL CLERKSHIP IN MEDICINE
MED 877	HEMATOLOGY--ONCOLOGY, VAH
MED 880	GERIATRIC MEDICINE
MI 585	PATHOGENIC MICROBIOLOGY
MI 586	LABORATORY IN PATHOGENIC MICROBIOLOGY
MI 815	FIRST-YEAR ELECTIVE, MEDICAL MICROBIOLOGY AND IMMUNOLOGY
MKT 420	CONTEMPORARY MARKETING PROBLEMS
MNG 222	MINE LAW AND SAFETY
MNG 490G	EXPLOSIVES AND BLASTING ENGINEERING
MUS 563	MUSIC IN EARLY CHILDHOOD
MUS 630	BAROQUE PERFORMANCE PRACTICES
MUS 681	ADVANCED REHEARSAL TECHNIQUES - BAND
NEU 815	FIRST-YEAR ELECTIVE, NEUROLOGY
NEU 851	CLINICAL CLERKSHIP IN NEUROLOGY
NEU 855	ROTATION IN GERIATRIC NEUROLOGY
NFS 542	FOOD SERVICE EQUIPMENT AND LAYOUT
NUR 619	TEACHING IN NURSING
NUR 623	NURSING RESEARCH METHODS
OBG 815	FIRST-YEAR ELECTIVE, OBSTETRICS AND GYNECOLOGY
OBG 861	OUTPATIENT OBSTETRICS AND GYNECOLOGY
OBG 862	ACTING INTERNSHIP IN REPRODUCTIVE ENDOCRINOLOGY
OBI 850	ORAL BIOLOGY ELECTIVE
OPH 815	FIRST-YEAR ELECTIVE, OPHTHALMOLOGY
OSG 850	ORAL SURGERY ELECTIVE
PA 625	PUBLIC MANAGEMENT COMPUTER APPLICATIONS
PA 639	MANAGEMENT CONTROL SYSTEMS IN NON-PROFIT ORGANIZATIONS
PAT 660	CLINICAL TOXICOLOGY AND DRUG MONITORING
PAT 854	LABORATORY MEDICINE-REGIONAL BLOOD CENTER SERVICES
PDO 850	PEDIATRIC DENTISTRY ELECTIVE
PED 815	FIRST-YEAR ELECTIVE, PEDIATRICS
PED 868	AMBULATORY PEDIATRICS
PED 875	RESEARCH IN PEDIATRICS
PER 850	PERIODONTICS ELECTIVE
PHA 815	FIRST-YEAR ELECTIVE, PHARMACOLOGY
PHI 338	MORALITY AND BUSINESS
PHR 882	PHARMACY PRACTICE CLERKSHIP, MEDICINE
PHR 883	PHARMACY PRACTICE CLERKSHIP: AMBULATORY CARE
PHR 884	PHARMACY PRACTICE CLERKSHIP: SPECIALTY AREAS

PHR 885	HARMACY PRACTICE EXTERNSHIP ELECTIVE
PHY 508	OPTICS
PM 815	FIRST-YEAR ELECTIVE, PREVENTIVE MEDICINE AND ENVIRONMENTAL HEALTH
PS 454G	POLITICS OF LAND USE AND GROWTH MANAGEMENT
PS 785	PSYCHOLOGICAL BASES OF POLITICAL BEHAVIOR
PS 785	PSYCHOLOGICAL BASES OF POLITICAL BEHAVIOR
PSC 815	FIRST-YEAR ELECTIVE, PSYCHIATRY
PT 855	PHYSICAL THERAPY MANAGEMENT
PT 862	BIOETHICS: MORAL ISSUES IN HEALTH CARE
RAE 111	RUSSIAN ORAL PRACTICE
RAE 205	RUSSIAN PHONOLOGY AND PRONUNCIATION
RAE 310	RUSSIAN LISTENING AND ORAL PROFICIENCY
RAE 462G	ADVANCED READING IN THE SCIENCES AND TECHNOLOGY (IN RUSSIAN)
RAE 553	TEACHING OF RUSSIAN
RAE 480	RUSSIAN POETRY (IN RUSSIAN)
RBM 815	FIRST YEAR ELECTIVE, REHABILITATION MEDICINE
RBM 835	THIRD YEAR ELECTIVE, REHABILITATION MEDICINE
RM 815	FIRST-YEAR ELECTIVE, RADIATION MEDICINE
SOC 525	RELIGION, SOCIETY AND CULTURE
SOC 605	VALUES, RESEARCH, AND PUBLIC POLICY
SOC 606	APPLIED SOCIAL RESEARCH: AN OVERVIEW OF TYPES, USES AND DESIGNS
SOC 607	ADMINISTERING APPLIED SOCIAL RESEARCH PROGRAMS
SOC 608	INTERPRETING APPLIED SOCIAL RESEARCH
SOC 710	SPECIAL TOPICS IN SOCIAL ORGANIZATION
SPI 430	THE WORKS OF CERVANTES
STA 641	DESIGN AND ANALYSIS FOR VARIANCE COMPONENT MODELS
SUR 815	FIRST-YEAR ELECTIVE, SURGERY
SW 615	SOCIAL WORK IN WORK SETTINGS
TA 300	READINGS IN THEATRE (SUBTITLE REQUIRED)
TA 465	COSTUME DESIGN II
TOX 660	CLINICAL TOXICOLOGY AND DRUG MONITORING

7586C
(see also 7479C)

Biomedical Engineering:

GENERIC CURRICULUM

Course Number	Course Title	Hrs.	Comments
Prerequisites			
ACC 201	Accounting I	3	
ECON 201	Micro Economics	3	required for all UK engineering students
BIO 515	Cell Biology	3	
BME 501	Foundations of BME (or equiv)	3	
BME 530	Biomedical Instrumentation (or equiv)	3	
Fall Year 1			
BME 6XX	BME Technical Elective	3	
PGY 412 G	Principles of Human Physiology	4	
BME 642	Navigational Guides for Biomedical Product Design	2	new course: patents, standards, ethics, FDA regs
HA 621	Quantitative Methods of Research	3	(statistical analysis)
PA 642	Public Organization Theory & Behavior	3	
Seminar	seminar	0	
		15	
Spring Year 1			
BME 6XX	BME Technical Elective	3	
PA 623	Decision Analysis	3	
HA 601	Healthcare System Overview	3	
HA 637	Health Finance	3	
MKT 600	Marketing Management	3	
Seminar	seminar	0	
		15	
Summer Internship	(required)		Advanced Study Project related
Fall Year 2			
BME 6XX	BME Technical Elective	3	
BME 767	Management of Technology	3	new course
HA 602	Strategic Planng & Mgmt of HC Orgs	3	may substitute a Finance elective
BME 777	Advanced Study Project	3	new course
Seminar	seminar	0	
		12	
	Total Program Credits	42	

General (Non-Track) Program

Course	Title	Hrs.	Comments
Prerequisites			
ACC 201	Accounting I	3	
ECON 201	Micro Economics	3	
BIO 515	Cell Biology	3	
BME 501	Foundations of BME (or equiv)	3	
BME 530	Biomedical Instrumentation (or equiv)	3	

Fall Year 1			
BME 670	Biomechanics I (Continuum mechanics)	3	
PGY 412 G	Principles of Human Physiology	4	
BME 642	Navigational Guides for Biomedical Product Design	2	new course: patents, standards, ethics, FDA regs
HA 621	Quantitative Methods of Research	3	(statistical analysis)
PA 642	Public Organ Theory & Behavior	3	
Seminar	seminar	0	
		15	
Spring Year 1			
BME 605	Biomedical Signal Processing I	3	
PA 623	Decision Analysis	3	
HA 601	Healthcare System Overview	3	
HA 637	Health Finance	3	
MKT 600	Marketing Management	3	
Seminar	seminar	0	
		15	
Summer Internship	(required)		Advanced Study Project related
Fall Year 2			
BME 661	Biomaterials Science and Engineering	3	
BME 767	Management of Technology	3	new course
HA 602	Strategic Planng & Mgmt of HC Orgs	3	Finance elective recommended
BME 777	Advanced Study Project	3	new course
Seminar	seminar	0	
		12	
	Total Program Credits	42	

Biomedical Controls & Signal Processing Track

Course	Title	Hrs.	Comments
Prerequisites			
ACC 201	Accounting I	3	
ECON 201	Micro Economics	3	
BIO 515	Cell Biology	3	
BME 501	Foundations of BME (or equiv)	3	
BME 530	Biomedical Instrumentation (or equiv)	3	
Fall Year 1			
BME 605	Biomedical Signal Processing I	3	
PGY 412 G	Principles of Human Physiology	4	
BME 642	Navigational Guides for Biomedical Product Design	2	new course: patents, standards, ethics, FDA regs
HA 621	Quantitative Methods of Research	3	(statistical analysis)
PA 642	Public Organ Theory & Behavior	3	
Seminar	seminar	0	
		15	
Spring Year 1			

BME 610	Biomedical Control Systems I	3	
PA 623	Decision Analysis	3	
HA 601	Healthcare System Overview	3	
HA 637	Health Finance	3	
MKT 600	Marketing Management	3	
Seminar	seminar	0	
		15	
Summer Internship	(required)		Advanced Study Project related
Fall Year 2			
BME 6XX	Biomedical Signal / Controls Tech Elective	3	BME 615 or 620
BME 767	Management of Technology	3	new course
HA 602	Strategic Planng & Mgmt of HC Orgs	3	may substitute a Finance elective
BME 777	Advanced Study Project	3	new course
Seminar	seminar	0	
		12	
	Total Program Credits	42	

Biomechanics Track

Course	Title	Hrs.	Comments
Prerequisites			
ACC 201	Accounting I	3	
ECON 201	Micro Economics	3	
BIO 515	Cell Biology	3	
BME 501	Foundations of BME (or equiv)	3	
BME 530	Biomedical Instrumentation (or equiv)	3	
Fall Year 1			
BME 670	Biomechanics I (Continuum Mechanics)	3	
PGY 412 G	Principles of Human Physiology	4	
BME 642	Navigational Guides for Biomedical Product Design	2	new course: patents, standards, ethics, FDA regs
HA 621	Quantitative Methods of Research	3	(statistical analysis)
PA 642	Public Organ Theory & Behavior	3	
Seminar	seminar	0	
		15	
Spring Year 1			
BME 672	Biomechanics II (Musculoskeletal mechanics)	3	
PA 623	Decision Analysis	3	
HA 601	Healthcare System Overview	3	
HA 637	Health Finance	3	
MKT 600	Marketing Management	3	
Seminar	seminar	0	
		15	
Summer Internship	(required)		Advanced Study Project related
Fall Year 2			

BME 685	Biomechanics III (Biofluid mechanics)	3	or advanced Topic in Biomechanics
BME 767	Management of Technology	3	new course
HA 602	Strategic Planng & Mgmt of HC Orgs	3	may substitute a Finance elective
BME 777	Advanced Study Project	3	new course
Seminar	seminar	0	
		12	
	Total Program Credits	42	

Biomaterials Track

Course	Title	Hrs.	Comments
Prerequisites			
ACC 201	Accounting I	3	
ECON 201	Micro Economics	3	
BIO 515	Cell Biology	3	
BME 501	Foundations of BME (or equiv)	3	
BME 530	Biomedical Instrumentation (or equiv)	3	
Fall Year 1			
BME 661	Biomaterials Science and Engineering	3	
PGY 412 G	Principles of Human Physiology	4	
BME 642	Navigational Guides for Biomedical Product Design	2	new course: patents, standards, ethics, FDA regs
HA 621	Quantitative Methods of Research	3	(statistical analysis)
PA 642	Public Organ Theory & Behavior	3	
Seminar	seminar	0	
		15	
Spring Year 1			
BME 662	Tissue Implant Interface	3	
PA 623	Decision Analysis	3	
HA 601	Healthcare System Overview	3	
HA 637	Health Finance	3	
MKT 600	Marketing Management	3	
Seminar	seminar	0	
		15	
Summer Internship	(required)		Advanced Study Project related
Fall Year 2			
BME 6XX	BME Technical Elective	3	or Advanced Topic in Biomaterials
BME 767	Management of Technology	3	new course
HA 602	Strategic Planng & Mgmt of HC Orgs	3	may substitute a Finance elective
BME 777	Advanced Study Project	3	
Seminar	seminar	0	
		12	
	Total Program Credits	42	