University of Georgia

Proposal

for

Doctor of Philosophy with Major in Engineering

Institution: University of Georgia

Date: May 23, 2011

College/Unit: Institute of the Faculty of Engineering

Name of the Proposed Program: Doctor of Philosophy with major in Engineering

Degree: Ph.D.

Major: Engineering

Starting Date: Fall 2012

Approved by: E. Dale Threadgill, Director, Faculty of Engineering

Sr. Vice President and Provost President of the University

Prepared by the Faculty of Engineering:

William Kisaalita, Faculty of Engineering, Biological and Agricultural Engineering

Brahm Verma, Faculty of Engineering, Biological and Agricultural Engineering
1. PROGRAM ABSTRACT

Provide in a one or two page abstract a summary of the proposed program. This section should be written in a manner suitable for presentation to the Board of Regents and should briefly state the objectives of the program, identify the needs which the program would meet, and include information related to costs, curriculum, faculty, facilities, desegregation impact, enrollment, etc.

This is a proposal from the University of Georgia (UGA) Faculty of Engineering (FE) to offer a “Doctor of Philosophy with major in Engineering” degree. The goal is to educate engineer-scholars and future teachers needed for opportunities of the 21st Century. Specific objectives are:

1. To educate future engineers in the discovery of knowledge through a curriculum in advanced engineering science that fosters independent research and scholarship, and prepares next generation thinkers and change makers to understand the intricacies of problems in the complex webs of interconnections of the 21st Century and integrate discoveries and knowledge of multiple fields for creating farsighted solutions;

2. To educate students in the application of new knowledge and entrepreneurial skills in a responsive learning environment that prepares future engineers to innovate 21st Century technology; and

3. To educate students in the teaching of new knowledge to future generations of scholars and practitioners.

Graduate degree programs at the Ph.D. level are the backbone of a research university. Graduate students are a critical link to frontier research. Outstanding faculty cannot be recruited without access to outstanding graduate students. The proposed degree will enable the creation of advanced technologies through discoveries of scientific research, particularly in biological and other complex systems where the University of Georgia has nationally prominent programs, and also meet society’s future needs for engineers who are integrators, innovators and problem solvers in the complex-interconnected world of globalization. The proposed Ph.D. in Engineering degree is not designated to any specialized engineering discipline or field but open to making new and unique connections with disciplines and fields of study important for future needs. As compared to a Ph.D. in a “named” area of engineering (e.g., Mechanical Engineering or Electrical Engineering), the Ph.D. in Engineering will encourage exploration of new engineering approaches and would not require renaming the degree with the emergence of new engineering fields. The rigor for quality and an open structure for connecting and integrating for solving problems at the interstices of complex webs are what this degree will offer. Increasingly there are more nontraditional students who wish to interface multiple disciplines and choose an engineering degree at the graduate level after a degree in science or mathematics. These students bring additional perspectives to the graduate engineering experience. This is a direction by which future engineering knowledge and practice will benefit. It will also provide leaders and scholars needed by the state and nation to maintain a leadership position in our highly competitive world.
Addressing the question of student demand passively by only considering past trends, (i.e., number of U.S. engineering graduates and job projections) is not likely to serve the region well in the future and create the desired Global Georgia. While addressing the market for engineers, Charles Vest, President of the National Academy of Engineering, asked: “The world is changing remarkably fast, and leadership in science and engineering will drive it. Where will this leadership come from? China? India? The United States? The choice is ours to make.” Studies report that Georgia relies on immigration from other states and other countries to fill nearly half of all engineering jobs in the state, and less than two-thirds of the qualified Georgia high school graduates (SAT scores of 1100 to 1600) with an expressed interest in majoring in engineering were enrolled in engineering in USG institutions of higher education. Additionally, USG is expecting a continued increase in enrollment in the coming decade. No institution in the state offers a Ph.D. in Engineering degree similar to the proposed degree objectives.

The University of Georgia, with the arts, humanities and all sciences underpinning engineering, provides the opportunity to develop genuine engineering scholars and thinkers capable of integrating diverse perspectives and innovating solutions for problems in commerce, finance, education, health care, infrastructure, transportation, communication, and many other sectors of interacting societies. This degree at UGA will be supported by exceptional faculty and outstanding facilities in sciences and arts and a series of interdisciplinary centers of excellence. UGA faculty and academic resources will support needs for the degree through the new engineering programs recently approved and funded.

UGA has a very strong commitment to recruiting students from underrepresented groups. Under the leadership of President Michael Adams the University has made significant progress. The open structure that invites non-traditional students and opportunity to integrate such disciplines as biology, ecology and public health are particularly attractive to women and other underrepresented groups. This program will actively recruit students and faculty from these groups and build partnerships with colleges and universities whose student body is predominantly from them. UGA already has more than 50 percent women students who will be targeted for this degree program. Partnerships with the Honors program and active participation with the Center for Undergraduate Research Opportunity (CURO) will invite outstanding undergraduate non-engineering majors to this program. There is strong evidence that public health, biology, ecology/environment, and the interplay among sustainable systems, technology and society, attract women and underrepresented minorities.
2. OBJECTIVES OF THE PROGRAM

List the program objectives and indicate how they are related to the mission and strategic plan of the institution, as filed with the Office of the Vice Chancellor for Research and Planning.

This is a proposal from the University of Georgia (UGA) Faculty of Engineering (FE) to offer a “Doctor of Philosophy with major in Engineering” degree. The goal is to educate engineerscholars and future teachers needed for opportunities of the 21st Century. Specific objectives are:

1. To educate future engineers in the discovery of knowledge through a curriculum in advanced engineering science that: 1) fosters independent research and scholarship, 2) prepares next generation thinkers and change makers to understand the intricacies of problems in the complex webs of interconnections of the 21st Century, and 3) integrate discoveries and knowledge of multiple fields for creating farsighted solutions;

2. To educate students in the application of new knowledge and entrepreneurial skills in a responsive learning environment that prepares future engineers to innovate 21st Century technologies; and

3. To educate students in the teaching of new knowledge to future generations of scholars and practitioners.

Graduates are expected to be leaders with advanced technical knowledge in science and engineering, a creative mindset and entrepreneurial skills. They will be prepared for successful careers as teachers, researchers, and inventive engineers in a world of unpredictable future changes. They will learn about university-industry-government interactions by preparing research proposals, papers, and disclosures of intellectual property for competitive peer evaluation. They will also have opportunities to master essential skills for introducing products in start-up and large company environments.

This program is consistent with the University of Georgia's social contract as a land- and sea-grant institution to provide citizens of Georgia with opportunities to study and learn, to expand the bounds of old knowledge, to discover new knowledge, and to improve the quality of life.

UGA’s Strategic Plan, The First Decade of the 21st Century, included “Comprehensive Engineering: A Strategic Institutional Initiative.” The goal of this initiative was to establish new academic studies in engineering and research inspired simultaneously by considerations of use and by the quest for fundamental understanding. It would not pursue a traditional model with separated departments and academic specialties, but would instead implement an evolutionary approach designed to bring many disciplines to bear on the complex problems of our time.
The UGA Faculty of Engineering (FE) has been a model for this since its inception on October 1, 2001. The present proposal mirrors the essential interdisciplinarity of the FE, and now endeavors to take this to the next level by forging it into a formal graduate academic program inspired by the same goals that not only serve UGA’s Strategic Plan, but also the University System of Georgia's (USG) Strategic Goals as follows:

**USG Strategic Goal One** – *Renew excellence in undergraduate engineering education to meet students’ 21st century educational needs*

Graduate students enrolled in the proposed PhD-E degree program will be exemplars for undergraduate and Masters-level engineering students and will create a “near-peer” learning environment that contributes to undergraduate engineering education excellence.

**USG Strategic Goal Two** – *Create enrollment capacity to meet needs of 100,000 additional students by 2020*

The proposed PhD-E degree will add enrollment capacity to meet the increasing demand in Georgia and the nation for U.S.-educated engineer-scholars and teachers.

**USG Strategic Goal Three** – *Increase the USG’s participation in research and economic development to the benefit of a Global Georgia.*

The central objective of the proposed PhD-E degree is to address this strategic goal. Graduates of the program will fill a key role in the continuum between discovery and knowledge transfer to invent and introduce new technology for economic development, and will serve as a lynchpin in the "Global Georgia" concept.

**USG Strategic Goal Four** – *Strengthen the USG’s partnership with the state’s other education agencies.*

This proposed major in "Engineering" is an important element in the education of engineers for 2020 and beyond. The degree will be adaptive and responsive to opportunities accorded by unpredictable combinations of discoveries from the multiple fields of science. In Georgia, the University of Georgia is uniquely positioned to offer a Ph.D. degree with these unique characteristics because of its academic programs in all areas of sciences, applied sciences, humanities and the arts, as well as the recent addition of public health and medicine. This proposed degree program does not duplicate other engineering programs, rather it complements them and promises to create an environment in which students will be catalysts and faculty will forge partnerships with other USG institutions to benefit from their strengths, and they from ours.
a. Indicate the societal need for graduates prepared by this program. Describe the process used to reach these conclusions, the basis for estimating this need, and those factors that were considered in documenting the program need.

During the past five years numerous studies have concluded that there are growing concerns about the need for more U.S.-educated engineers, and for future engineering to differ from past engineering to better address the needs of the 21st century. Most compelling studies are:

- "Moving Forward to Improve Engineering Education," National Science Board (NSB, 2007)
- "The National Innovation Initiative, Council of Competitiveness" (Council of Competitiveness, 2006)

These studies conclude that globalization across many fronts will call upon the new engineers to interact with other citizens of the world, technical and nontechnical, to solve problems that transcend traditional boundaries of nation-states. These problems will not be locally contained in time and space, but will instead be distributed and hidden in the interstices of complex webs of interconnection – in commerce, finance, education, health care, infrastructure, transportation, communication, and many other sectors of interacting societies.

Engineering has many definitions. Joseph Bordogna, former Deputy Director of the National Science Foundation, found Fumio Kodama’s definition poignant: "Engineering is the integration of all knowledge to some purpose.” Unlike the specialized characteristic of scientific inquiry, engineers are society’s master integrators. They work across different disciplines and fields, make connections for deeper insights to understand the intricacies of the problems and imagine creative solutions; in other words, they are into getting things done. Thus, engineering education is under increasing pressure to move away from specialization to a more comprehensive education that better connects and integrates discoveries and knowledge from multiple fields.

The University of Georgia began focusing on the changing engineering needs and their importance to Georgia and the nation in 1992. Over the years it studied emerging trends influenced by the growing understanding of complex systems and holistic approaches in
engineering. UGA Engineering organized university-wide symposia and discussions with national leaders and visited change-making programs such as Olin College in Needham, MA. It began implementing actions to address these changes; some of these precede the first high-profile national report published in 2005 listed above. In 2001, UGA established the Faculty of Engineering with the central objective “to increase opportunity for learning, research and outreach at the confluence of disciplines – preparing students for careers devoted to the integration of discoveries from multiple fields.” The three undergraduate degrees proposed by the Faculty of Engineering in 2003 and approved by the Board of Regents in 2005 were designed to move away from classical specializations to a more comprehensive engineering education in a liberal arts environment. The character and content of these proposals addressed the critical conclusions of the aforementioned studies.

Another factor looms in the coming times as well. With the accelerating growth of technical knowledge and need to make connections with other fields of study, it is becoming evident that it is no longer possible to build the content of the four-year undergraduate engineering curriculum that meets the needs of this profession. Today, engineering is one of the very few knowledge-intensive professions that require only the undergraduate degree for professional status. The inadequacies of the undergraduate degree for professional practice are increasingly causing employers to look for Master’s or Ph.D. graduates for technical work. Building a baccalaureate through doctoral level continuum of engineering education at UGA is important for meeting the future needs of the state, region and nation and it is critical for the engineering profession.

Graduate degree programs at the Ph.D. level are the backbone of a research university. Graduate students are a critical link to frontier research. Outstanding faculty cannot be recruited without access to outstanding graduate students. The proposed degree will enable the creation of advanced technologies through discoveries of scientific research, particularly in biological and other complex systems where the University of Georgia has nationally prominent programs, and also meet society’s future needs for engineers who are integrators, innovators and problem solvers in the complex-interconnected world of globalization. The proposed Ph.D. in Engineering degree is not designated to any specialized engineering discipline or field but open to making new and unique connections with disciplines and fields of study important for future needs. As compared to a Ph.D. in a “named” area of engineering (e.g., Mechanical Engineering or Electrical Engineering), the Ph.D. in Engineering will encourage exploration of new engineering approaches and would not require renaming the degree with the emergence of new engineering fields. The rigor for quality and an open structure for connecting and integrating for solving problems at the interstices of complex webs are what this degree will offer. Increasingly there are more nontraditional students who wish to interface multiple disciplines and choose an engineering degree at the graduate level after a degree in science or mathematics. These students bring additional perspectives to the graduate engineering experience. This is a direction by which future engineering knowledge and practice will benefit. It will also provide leaders and scholars needed by the state and national to maintain a leadership position in our highly competitive world.
b. Indicate the student demand for the program in the region served by the institution. What evidence exists of this demand?

The University System of Georgia’s (USG) Strategic Goal Three is to “Increase the USG’s participation in research and economic development to the benefit of a Global Georgia.” Georgia must increasingly compete not only within fifty states, but also with other countries, create and attract intellectual resources, draw the best talent, and control its own future in a global economy. To achieve this strategic goal Georgia has to increase the number of scientists and engineers in its workforce and, thus, move up from being the 40th state in this category (The U.S. Council of Competitiveness, 2000).

The projection of student demand for the proposed Ph.D. in Engineering requires a study not only of the historic student enrollment in engineering programs in Georgia and the United States (which is projected to increase by 11% between 2006 and 2016), but also the consideration of factors that may affect an increase in engineering enrollments due to new opportunities and new engineering approaches proposed herein.

Currently at the undergraduate-level, the U.S. produces only 8% of engineers globally each year, and only 4.5% of college students major in engineering as compared to 12% in Europe and 40% in Asia. The number of U.S. baccalaureate engineering graduates peaked to 85,000 in 1985 but then dropped by over 24,000 to 61,000 in mid-1990s. It seems to have stabilized at about 74,000 in 2007. This rate of graduation provides a small pool of students for U.S. engineering graduate programs. Such a small number of engineering graduates is grossly inadequate to fill a reasonable percent of even Master’s level seats (which peaked at 91,000 students in 2003) with U.S. graduates. As Master’s and Ph.D. degrees continue to become requirements for engineering practice, building a strong continuum of undergraduate and graduate engineering education is essential to meeting state and national needs.

In 2006, the U.S. graduated over 39,000 Master’s degree engineering students (total enrollment was 83,000) and over 8,300 Ph.D. students (total enrollment was 57,000). Nearly 40% of the engineering Master’s degree recipients and 61% of the new engineering Ph.D. degrees were granted to foreign nationals. In 2006, China graduated 8,000 Ph.D. degrees, nearly the same as the U.S. While the change in number of Ph.D. engineering graduates in the U.S. is modest, China is doubling its Ph.D. graduation rate every 5 years.

Addressing the question of student demand passively by only considering past trends, (i.e., number of U.S. engineering graduates and job projections) is not likely to serve the region well in the future and create the desired Global Georgia. Charles Vest (President Emeritus of MIT and the current President of NAE) stated that no one can look at today’s market for engineers and predict what students will experience in 30 years. Then he puts the question to us: “The world is changing remarkably fast, and leadership in science and engineering
will drive it. Where will this leadership come from? China? India? The United States? The choice is ours to make” (Clark Kerr Lectures. University of California Press, 2005).

The proposed Ph.D. in Engineering with its focus on future engineering that integrates disciplines will be attractive not only to students with engineering degrees, but also to talented graduates from other disciplines, particularly the graduates of science and mathematics. Engineering knowledge is increasingly driven by the complexity of such fields as biology and ecology as well as by systems science rather than by the current and past reductionism of physics and engineering practice. Future engineering education must also accommodate globalization affecting technology, commerce and politics. Many non-engineering graduates interested in solving problems in these complexities will be attracted to this degree program.

UGA, as one of the nation’s leading research universities with extensive leadership in many areas of science, humanities and arts, and a prime engine of the state’s economic and human development, will provide unique opportunities to students enrolled in the proposed degree program. The heightened interplay between sciences and engineering and research and development at UGA will prepare highly competent next generation engineers ready to lead in the integration of knowledge for revealing and understanding complex problems and creating futuristic technological solutions.

c. Give any additional reasons that make the program desirable (for example, exceptional qualifications of the faculty, special facilities, etc.)

The University of Georgia, the largest and most culturally diverse campus in Georgia with the arts, humanities and all sciences underpinning engineering, uniquely provides opportunity to develop genuine engineering scholars and thinkers capable of integrating diverse perspectives and innovating solutions for problems in commerce, finance, education, health care, infrastructure, transportation, communication, and many other sectors of interacting societies. This degree at UGA will be supported by exceptional faculty and outstanding facilities in sciences and arts and a series of interdisciplinary centers of excellence. For example, distinguished faculty in biological and physical sciences and in applied sciences addressing issues related with energy, health, infectious diseases, environment and bio- and natural-resource systems, and many prominent research centers and laboratories, are most valuable and required resources for the proposed degree.

Recognizing that strong graduate programs are critical to the future of the University, the Provost and the Dean of the Graduate School charged a 28-member Task Force in September 2006 to provide recommendations on three major challenges facing the quality of graduate education in all areas of the academy: Innovation, Interdisciplinarity, and Inclusiveness. The proposed degree, accessible to students from multiple disciplines with open structure to form connections and integration, has a high potential for meeting the three challenges. Students who are graduates of multiple disciplines will naturally build a culture of interdisciplinarity. Because of the comprehensiveness of the University of Georgia, it is positioned to offer this degree like no other institution in the State of Georgia.
Georgia needs more engineers. While Georgia’s growth and its stature among states rose in the decade of the 90’s in some important categories (for example, 4th in population growth, 8th in venture capital investment, and 8th in start-up companies), it ranked 40th in the nation in percentage of engineers and scientists in its workforce [The U.S. Council of Competitiveness, 2000 Report]. The February 2002 report by the Washington Advisory Group [Commissioned by the University System of Georgia Board of Regents] notes that Georgia relies on immigration from other states and other countries to fill nearly half of all engineering jobs in the state.

There is also a need to increase the state of Georgia’s capacity for engineering education. Another University System of Georgia (USG)-commissioned report on engineering education needs published in 1998 presented data showing that less than two-thirds of the qualified Georgia high school graduates (SAT scores of 1100 to 1600) with an expressed interest in majoring in engineering were enrolled in engineering in USG institutions of higher education. The Georgia Financial Commission recognized the need for Georgia to graduate more engineers when it created, under the HOPE Scholarship Program, a “Scholarship for Engineering Education (SEE)” with the objective “To provide service-cancelable loans to Georgia residents who are engineering students at private accredited engineering universities in Georgia and retain them as engineers in the State.” With the increasing need for Master’s and Ph.D. degree engineers to enter and succeed in the engineering profession, the adding of capacity to offer graduate degrees is becoming imperative for future engineering.

Since 2001, prominent participants in the UGA organized engineering symposia, numerous invited distinguished guest-lectures (including the immediate past president of NAE and the President of Olin College) and the UGA Engineering Advisory Board composed of nine distinguished leaders from industry, government and academia have commended the UGA Faculty of Engineering as both innovative and farsighted. They have unanimously and strongly recommended the addition of a Ph.D. degree molded in the conceptual framework of the UGA Comprehensive Engineering and the UGA Engineer profile. The proposed degree is molded by these views that also align with the recommendations of the several cited NAE and the University of Michigan Millennium Project reports published since 2005.

e. List all public and private institutions in the state offering similar programs. If no such program exists, so indicate.

No institution in the state offers a Ph.D. in Engineering degree similar to the proposed degree objectives.
Georgia Institute of Technology’s Ph.D. degrees in engineering are offered by several disciplinary units with commensurate disciplinary objectives. Its bioengineering program is an interdisciplinary degree available to most of the engineering academic units interfacing aspects of biology in their disciplinary perspectives.

4. PROCEDURE USED TO DEVELOP THE PROGRAM

Describe the process by which the committee developed the proposed program.

This proposal for a new graduate degree is a result of a deliberate process initiated in 1999 in response to the University’s Strategic Plan for the First Decade of the 21st Century.

In February 2000, a position paper prepared by Professors Brahm Verma and Dale Threadgill entitled “Comprehensive Engineering at UGA” was submitted to the Vice President for Strategic Planning with the request that Engineering be included as a Strategic Issue in the University’s Strategic Plan. The “Comprehensive Engineering at UGA” paper identified Georgia needing more engineers and how the University of Georgia had the responsibility and capacity for developing new approaches for future engineering. It proposed a strategic approach to build engineering in a new way and advance the institution’s capacity for meeting not only the shortage of engineers, but also for educating engineers of the future. It demonstrated that Comprehensive Engineering will add new dimensions to the University that will provide advanced technology for research in highly complex systems, including biology and ecology and the ability to rapidly translate scientific discoveries into technology. The University Strategic Planning Advisory Board included Engineering as a new Strategic Institutional Initiative, and it is now a part of the UGA Plan for the first decade of the millennium.

In April 2001, a Symposium, Towards 2010: Comprehensive Engineering at UGA, was held to engage UGA faculty from across campus in a daylong effort to identify engineering initiatives of significance and to articulate ways in which Comprehensive Engineering will strengthen a range of UGA programs. More than 100 faculty members from 9 Colleges/Schools participated in the Symposium. Thirteen faculty members highlighted engineering opportunities in research, graduate and undergraduate studies, and outreach. Their perspectives represented the disciplines of physics, chemistry, pharmacy and health sciences, biochemistry and molecular biology, veterinary sciences, computer science, mathematics, ecology, marine sciences, environmental sciences, textile science, food science, business and engineering. They identified the important dimensions in which the University’s current programs are unable to grow due to lack of Comprehensive Engineering at UGA and shared experiences on how the University has been handicapped in capitalizing on opportunities for meeting the needs of the state of Georgia. At that time (i.e., in 2001) the UGA faculty identified the following ten engineering program areas as high priority needs and opportunities: bioprocess/biochemical engineering, metabolic engineering, pharmaceutical engineering, nanotechnology, ecological/environmental engineering, information/computer systems engineering, sensors and controls, marine engineering, engineering management and engineering education. A task committee with membership
including UGA faculty from diverse but related disciplines was formed for each of these program areas and charged with further developing the needs and opportunities. Another task committee was charged with proposing ideas to create an innovative approach for organizing Comprehensive Engineering at UGA. The concept of a Faculty of Engineering originally proposed in the “Comprehensive Engineering at UGA” document was recommended. The UGA Faculty of Engineering was formally established on October 1, 2001, with Dr. E. Dale Threadgill appointed as its Director.

To gain insight from state and national leaders about building programs in the UGA Faculty of Engineering a second daylong Symposium, Towards 2010: Faculty of Engineering at UGA, was organized with invited leaders from industry, business, government agencies and academia participating. The Symposium, held in April 2002, was open to the UGA faculty. More than 100 individuals attended the Symposium. UGA President Michael Adams in his opening remarks explained the needs for engineers in the state of Georgia. He cited the February 2002 report, prepared by a Washington Advisory Group commissioned for the Board of Regents, conclusively stating that Georgia relies on immigration from other states and other countries to fill nearly half of all engineering jobs in the state. President Adams further stated, “UGA has a social and charter responsibility as Georgia's flagship institution to provide innovative services for the economic development of the state. Engineering is a key linchpin in this effort.” Dean Kristina Johnson from Duke University (now Provost and Senior Vice President of academic Affairs at Johns Hopkins University) stated that a “modern research university is incomplete and obsolete without comprehensive engineering.” Discussions during breakout sessions reinforced the need for engineering in the program areas identified at the 2001 Symposium as well as identified new opportunities with biomedical engineering. At the conclusion of the April 2002 Symposium, the UGA Faculty of Engineering established several task groups and charged them with developing academic programs and other recommendations for meeting the identified engineering needs.

These seminal events began a course for the development of Comprehensive Engineering at UGA. Actions listed below have been key contributors to the process of identifying the need for the proposed degree.

- Since 2002, receiving regular advice and recommendations of the UGA Engineering Council (made up of UGA faculty from multiple disciplines) who study future trends and review progress of Comprehensive Engineering at UGA.
- Since 2003, studies to identify future engineering directions and needs that led to successful undergraduate and graduate degree proposals in BioChemical Engineering and Environmental Engineering built from the “systems and engineering ecology” prospective, and an undergraduate degree in Computer Systems Engineering.
- In 2006, the UGA Think Tank report defined the profile for a UGA Engineer. This recommendation formed the core for UGA engineering program curricula and the basis for the recruitment of faculty and students.
- In 2007, Dr. William Wulf, the Immediate Past President of the National Academy of Engineering (NAE) during his visit to UGA for the inaugural presentation in the Distinguished Engineering Lecture Series commended the UGA’s foresighted
approach to engineering and identified the importance of M.S.- and Ph.D.-level
degree programs for furthering the vision of Comprehensive Engineering and the
University of Georgia’s research and educational mission.

- In 2008, the Faculty of Engineering Advisory Board in its inaugural meeting in
  November made strong and unequivocal recommendation for the need for graduate-
  level engineering degrees. They also recommended that the degree should be
  “Engineering” with the flexibility to create new and unique integrations for solving
  problems of the future.

This proposal is a result of these deliberate efforts. The faculty and student participants in
this program will be from all corners of the University. The program will attract outstanding
students with engineering and non-engineering degrees. The range of the development of
future technology for solving complex problems will exceed the norms of the past. In
Georgia, the Georgia Institute of Technology offers numerous discipline-based engineering
Ph.D. degrees and a degree in bioengineering which is interdisciplinary with several
engineering departments. No institutions in the state offer a Ph.D. in Engineering degree.

The philosophy of engineering on the UGA campus was the guiding framework in preparing
this Ph.D. in Engineering program. The proposal was prepared with the support and input
of faculty in UGA Engineering and related UGA Colleges/Schools.

5. CURRICULUM

List the entire course of study required and recommended to complete this degree program. Give a sample
program of study that might be followed by a representative student. Indicate also the existing courses and any
new courses that will be added. Append a course description for existing courses as well as new courses that will
be added.

Requirements for the PhD-E degree will include completion of course requirements in
compliance with the University of Georgia Graduate School requirements. That is, a
student’s program of study will include a minimum of 24 semester credit hours, of which 16
credit hours must be courses at the 8000/9000 levels exclusive of research/dissertation
hours. To receive the PhD-E degree, each student will be required to pass a qualifying
examination and a comprehensive examination, and successfully defend the dissertation.

Each student will have an advisory committee consisting of a major professor and four
additional members as per the University guidelines. The committee is responsible for
ensuring the quality of the program of study and research. It is the prerogative of each
student’s advisory committee, in consultation with the student, to plan and supervise all
aspects of the doctoral study. The committee will be responsible for preparing the program
of study, administering examinations, and assessing quality of the dissertation in
accordance with Graduate School requirements and accepted national standards

The program of study of each student will be designed to achieve the objectives of the
degree program. The required 9 hours of courses cover core topics: research methods,
design methods, computational methods, entrepreneur skills, teaching skills and seminar. The remaining courses are selected to provide fundamental knowledge in the selected areas of sciences for interfacing with engineering, advanced engineering sciences, and enabling mathematical sciences (including statistics and computational methods) to build the foundation for scholarly inquiry in the dissertation research area. Four example programs of study are presented below, each showing a different field of interest in engineering.

**EXAMPLE #1**  
**Ph.D. in Engineering**  
(Students integrating to advance engineering knowledge from molecular biology, electronics and nano-science to create nano-level devices and systems)

**Required Courses (8-10 hours)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 8910 (new)</td>
<td>Research and Design Methods</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 6101, 8102, 8103</td>
<td>Computational Methods Modules</td>
<td>3¹</td>
</tr>
<tr>
<td>ENGG 8XX1, 8XX2</td>
<td>Technology Based Entrepreneurship</td>
<td>1-2</td>
</tr>
<tr>
<td>ENGG 8XX1, 8XX2</td>
<td>Effective Engineering Teaching Studio and Practicum in Engineering Teaching</td>
<td>1-2</td>
</tr>
<tr>
<td>ENGR 8950</td>
<td>Graduate Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

**Selected Courses (21 hours)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 8160</td>
<td>Advanced Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>BCMB 6000</td>
<td>General Biochemistry and Molecular Biology</td>
<td>3</td>
</tr>
<tr>
<td>BCMB 8010</td>
<td>Advanced Biochemistry and Molecular Biology I</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 8310</td>
<td>MEMS Design</td>
<td>3</td>
</tr>
<tr>
<td>ENGG 8XXX</td>
<td>Advanced Nanoelectronics</td>
<td>3</td>
</tr>
<tr>
<td>STAT 6310</td>
<td>Statistical Analysis I</td>
<td>3</td>
</tr>
<tr>
<td>STAT 8200</td>
<td>Design of Experiments for Research Workers</td>
<td>3</td>
</tr>
</tbody>
</table>

1 Each of the three courses is 1 semester hour credit

**EXAMPLE #2**  
**Ph.D. in Engineering**  
(Students integrating to advance engineering knowledge for developing a fundamental knowledge base that can inform creative pedagogical techniques for educating future engineers)

**Required Courses (8-10 hours)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 8910 (new)</td>
<td>Research and Design Methods</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 6101, 8102, 8103</td>
<td>Computational Methods Modules</td>
<td>3</td>
</tr>
<tr>
<td>ENGG 8XX1, 8XX2</td>
<td>Technology Based Entrepreneurship</td>
<td>1-2</td>
</tr>
<tr>
<td>ENGG 8XX1, 8XX2</td>
<td>Effective Engineering Teaching Studio and Practicum in Engineering Teaching</td>
<td>1-2</td>
</tr>
<tr>
<td>ENGR 8950</td>
<td>Graduate Seminar</td>
<td>1</td>
</tr>
</tbody>
</table>

**Selected Courses (21 hours)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 8930</td>
<td>Systems Simulation and Optimization</td>
<td>3</td>
</tr>
<tr>
<td>ENGG 8XXX</td>
<td>Foundations of Engineering Education Research</td>
<td>3</td>
</tr>
</tbody>
</table>

**Page 14 of 74**
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGG 8XXX</td>
<td>Assessment Techniques in Engr Educ Research</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 8720</td>
<td>Mathematical Models in Physiology</td>
<td>3</td>
</tr>
<tr>
<td>ENGG 8110</td>
<td>Mathematical Biology</td>
<td>3</td>
</tr>
<tr>
<td>ERSH 8310</td>
<td>Applied Analysis of Variance Methods in Education</td>
<td>3</td>
</tr>
<tr>
<td>EPSY 6800</td>
<td>Foundations of Cognition for Education</td>
<td>3</td>
</tr>
</tbody>
</table>

**EXAMPLE #3**

**Ph.D. in Engineering**

(Students integrating to build engineering knowledge from complex ecological systems and for advancing sustainable designs. This example assumes that ENGR 8910 and ENGR 6101, 8102 and 8103 were completed at the MS level, thus they are not shown as ‘Required’. The equivalent number of hours have been transferred to ‘Selected Courses’.)

**Required Courses (2-4 hours)**
- ENGG 8XX1, 8XX2  Technology Based Entrepreneurship  1-2
- ENGG 8XX1, 8XX2  Effective Engineering Teaching Studio and Practicum in Engineering Teaching  1-2
- ENGR 8950   Graduate Seminar  1

**Selected Courses (25 hours)**
- ENGR(ECOL) 8560  Systems and Engineering Ecology  3
- ENGR 8160  Advanced Fluid Mechanics  3
- ENGR 8170  Advanced Heat Transfer  3
- ENVE 8110  Ecological Energetics  3
- STAT 8200  Design of Experiments for Research Workers  3
- ECOL 8220  Stream Ecology  2
- ECOL 8230  Lake Ecology  2
- MARS 8510  Modeling Marine Systems  3
- STAT 8300  Multivariate Analysis  3

**EXAMPLE #4**

**Ph.D. in Engineering**

(Students integrating to build engineering knowledge from biology for developing new materials)

**Required Courses (8-10 hours)**
- ENGR 8910 (new)  Research and Design Methods  3
- ENGR 6101, 8102, 8103  Computational Methods Modules  3
- ENGG 8XX1, 8XX2  Technology Based Entrepreneurship  1-2
- ENGG 8XX1, 8XX2  Effective Engineering Teaching Studio and Practicum in Engineering Teaching  1-2
- ENGR 8950   Graduate Seminar  1

**Selected Courses (24 hours)**
- ENGR 8XXX  Tissue Engineering for Drug Discovery  3
- CBIO 8050-8050L  Techniques in Modern Microscopy  4
- ENGR 8180  Advanced Mass Transfer  3
- ENGG(CHEM) 4615/6615  Soft Materials  3
- ENGR 4740/6740  Biomaterials  3
- STAT 8200  Design of Experiments for Research Workers  3
6. INVENTORY OF FACULTY DIRECTLY INVOLVED

The University of Georgia currently offers M.S. and Ph.D. degrees in five engineering areas. UGA also offers ABET-accredited undergraduate engineering degrees. All required courses in arts and sciences are already available from the UGA Franklin College of Arts and Sciences. Ten engineering faculty members currently offer core engineering science courses. The Faculty of Engineering has more than 60 UGA faculty with engineering degrees that provide a wide range of opportunity for graduate students in this degree program. The need for additional faculty is presented in Section 15.

The faculty who will be directly involved with the proposed degree program are listed below. Additional data on these faculty is provided in Appendix B.

Dr. Mark Haidekker, Faculty of Engineering
Dr. Jenna Jambeck, Faculty of Engineering
Dr. Kyle Johnsen, Faculty of Engineering
Dr. Caner Kazanci, Faculty of Engineering, Mathematics
Dr. William Kisaalita, Faculty of Engineering, Biol. & Agri. Engineering Dept.
Dr. Peter Kner, Faculty of Engineering,
Dr. Ke Li, Faculty of Engineering
Dr. Jason Locklin, Faculty of Engineering, Chemistry
Dr. Sudhagar Mani, Faculty of Engineering, Biol. & Agr. Engineering Dept.
Dr. Leidong Mao, Faculty of Engineering
Dr. Zhengwei Pan, Faculty of Engineering, Physics and Astronomy
Dr. John Schramski, Faculty of Engineering
Dr. Andrew Sornborger, Faculty of Engineering, Mathematics
Dr. William Tollner, Faculty of Engineering, Biol. & Agr. Engineering Dept.
Dr. Joachim Walther, Faculty of Engineering

7. OUTSTANDING PROGRAMS OF THIS NATURE IN OTHER INSTITUTIONS

List three outstanding programs of this nature in the country, giving location and name of official responsible for each program. Indicate features that make these programs stand out.

The University of Georgia’s proposed PhD in Engineering degree will provide students freedom to explore in whatever combination of disciplines that are needed and prepare them for the profession and academic inquiry as leading experts in the field. Dartmouth College offers PhD in Engineering with foci in three impact areas: Engineering in Medicine, Energy Technologies, and Complex Systems. Harvard University recently revived its engineering program and formed a School of Engineering and Applied Sciences in the Faculty of Arts and Sciences. It now offers a PhD in Engineering Sciences for keeping the interdisciplinary nature of modern research. Thus, these two programs stand out for the similarity in educational approaches and their contact information is listed below.
However, whereas the University of Georgia is a state-supported, land-grant university, both Dartmouth College and Harvard University are private institutions without the land-grant mission.

Three land-grant universities that are highly motivated for incorporating interdisciplinarity in their graduate-level engineering degrees and exhibit several features proposed in this PhD in Engineering proposal are the University of Florida, Purdue University and University of California at Davis. Contact information for these institutions is listed below:

Dr. Cammy Abernathy, Dean  
College of Engineering, University of Florida

Dr. Leah H. Jamieson, Dean  
College of Engineering, Purdue University

Dr. Bruce White, Dean  
University of California, Davis

8. INVENTORY OF PERTINENT LIBRARY RESOURCES

Indicate in number of volumes and periodicals, available library resources (including basic reference, bibliographic, and monographic works as well as major journal and serial sets) which are pertinent to the proposed program. What additional library support must be added to support the program?

The University of Georgia Library has several campus units. It has a comprehensive collection in arts, sciences and professional subjects and has an archival section that holds special historical documents. The Library has been a member of the Association of Research Libraries, a nonprofit organization of 122 of the largest research libraries in the U. S. and Canada, since 1967. In 2000, UGA was ranked 35th in the total number of volumes and 9th in total number of current serials owned.

The UGA Library is the largest in the state with over 3.8 million volumes. On-line access to full text journals and serials is available both through a consortium of UGA, Emory, Georgia Tech, Georgia State and Medical College of Georgia, and directly to the University of Georgia libraries. In addition, UGA is a leader nationally in offering electronic access to a wide range of electronic resources, including journal articles in full text. The statewide GALILEO system provides electronic access to hundreds of databases, including Chemical Abstracts, Engineering Index, Bioengineering Abstracts, Current Contents, etc. The University subscribes electronically to over 1000 Elsevier titles and to all titles published by Academic Press, Marcel Dekker, Spring Verlag, and Wiley Interscience.

The University Libraries have excellent print and electronic resources, particularly in chemistry, biological sciences, physics, mathematics and computer sciences, ecology.
and environmental sciences, agricultural sciences and earth sciences. The University of Georgia Science Library would provide the primary resource and support for the proposed program. Some relevant Science Library inventory and operational information is listed below.

a) Total volumes - 750,000 and its catalog is available over the Internet.

b) Volumes pertaining to the engineering and technology – nearly 100,000 and materials accessible via the Internet.

Generally, basic texts and references are available; however, some expansion will be needed as described in the following section.

State of Faculty Instructional Support and Additional Support Needs

State of collections in engineering sciences for the proposed degree programs is as follows:

- Reference Collection Adequate, but update will be required
- General Book Collection Additional books on engineering will be needed
- Periodicals, current Additional engineering periodicals will be needed
- Serials Adequate
- Documents Adequate

Projection

The Science Library has made steady progress in upgrading technical holdings. With modest designated funding increases, the library should provide good support for the proposed program. Ongoing improvement in the Science Library holdings will complement the engineering resources.

Additional Information on Library Resources

The Science Library provides reference help, interlibrary loan, circulation and collection development. It has 26 full-time staff including 8 librarians. It has about 750 seating capacity and is open 99.5 hours per week.

The University of Georgia Libraries' fiscal year Total Expenditures show a steady growth.

<table>
<thead>
<tr>
<th>Year</th>
<th>Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY-02</td>
<td>$21,545,504</td>
</tr>
<tr>
<td>FY-03</td>
<td>21,010,793</td>
</tr>
<tr>
<td>FY-04</td>
<td>21,544,004</td>
</tr>
<tr>
<td>FY-05</td>
<td>22,679,865</td>
</tr>
<tr>
<td>FY-06</td>
<td>23,014,039</td>
</tr>
<tr>
<td>FY-07</td>
<td>23,703,488</td>
</tr>
<tr>
<td>FY-08</td>
<td>24,451,142</td>
</tr>
</tbody>
</table>

Georgia Institute of Technology library would also be available to supplement the University’s resources in engineering.
9. FACILITIES

Describe the facilities available for the program. What new facilities and equipment are required?

The University of Georgia has extensive facilities available for the proposed degree program. The following is a selective list most related to the proposed program that gives the range and quality of facilities available for both undergraduate and graduate education.

A. Athens Campus

Instruction Labs:

**Applied Machine Vision Laboratory:** The Applied Machine Vision laboratory supports a course designed to provide students with experience in machine vision systems.

**Bio-Photonics Laboratory** is involved in optical sensing and optical imaging using the visible light spectrum. This includes fluorescent spectroscopy (some instruments are custom-designed to accommodate mechano-sensitive fluorescent molecular rotors), fluorescent imaging, fluorescent microscopy, laser-induced fluorescence. In addition, the lab has the capability of optical coherence tomography and a custom scattered-light confocal scanner exists. There are plans to add X-ray imaging and computed tomography with a custom-built instrument.

**Electronics and Electrical Laboratory** houses comprehensive facilities for teaching basic and advanced courses in electrical and electronic systems.

**Engineering Design Studio** provides dedicated computer facilities for rapid prototyping and CNC machining. Undergraduates enrolled in the sophomore-level Design Methodology course and the senior-level Engineering Project course are required to design, prototype and analyze a new product that meets a real-world need. Projects in these courses are typically sponsored by industry and are used by the companies to solve current problems.

**Engineering a Sustainable Environment:** The laboratory is located at Whitehall Bioconversion Center and is used in courses which focus on environmental monitoring, modeling and process design, solid waste management, hazardous waste management and concepts of risk assessment.

**Fluid Mechanics Laboratory** houses comprehensive facilities for teaching basic and advanced courses in electrical and electronic systems.

**General Computing Undergraduate Study Lab** occupies approximately 1228 ft² and is designed to provide general-purpose computing for undergraduates. This Study Lab is accessible to students for 90 hours per week.

**Industrial Controls Laboratory** is a teaching laboratory which exposes students to motor controllers and programmable logic controllers that are used in industrial control environments.

**Instructional Computer Laboratory** supports courses that require programming and
specialty software applications for Active Learning. This lab can be used for long-distance learning and on-line learning courses.

Materials Testing Laboratory: The laboratory is equipped to perform: 1) testing of engineering materials and biological materials, 2) properties of soils and granular materials, 3) load cell testing and calibration and photoelastic testing. This laboratory is equipped with equipment for measuring static and dynamics strains.

Micro-mechatronics Laboratory has 18 "Intellibrain" controller systems equipped with color vision systems, servo motors with wheel encoders, NIR and SONAR range sensors which can be used for various autonomous mechatronics projects.

Robotics Laboratory: This laboratory is design to support hands-on practice of robotics and mechatonics processes. This lab allows for the construction, programming and testing of multi-wheeled and multi-legged robots equipped with servo motors and sensors.

Smallholder Technology Laboratory focuses on research and development of products or processes to improve productivity among low income workers in developing countries. Research is done with undergraduate students through international capstone summer research experiences.

Spatial Data Collection: This laboratory provides fundamental capabilities for students to collect baseline data in collection, mapping and analysis of line-of-sight spatial data.

Undergraduate Teaching Laboratories include two laboratory/classroom areas which are dedicated to classroom labs. One laboratory is a dry lab and the other is a wet lab which contains hookups for gas, air, water and vacuum.

Research Labs:
Algae Laboratory is dedicated to the growth of algae, including harvesting and conversion technologies at the bench and pilot scales.

Alternative Fuels and Solvents Laboratory allows engineers to investigate the effects of different biological fuel mixtures on engine performance and reliability.

Analytical Laboratory houses chromatography equipment for the chemical analysis of various materials.

Applied Electrostatics Laboratory contains specialized high-voltage and low-current instrumentation facilitating the research and development of electrostatics processes for beneficial agricultural and biological applications.

Applied Machine Vision Laboratory is equipped with fiber-optic spectrometers, video imaging equipment, light sources and computer-controlled X-Y translation stages for sample presentation, allowing VIS/NIR spectrometry, spectral imaging and basic/high speed image acquisition and processing capabilities. Equipment in this lab is accessible to students via the Web.

Bioassessment Laboratory: Identification and characterization of benthic macroinvertebrates to support the watershed assessment research program. This laboratory is equipped with superb sampling equipment, D-frame and kick nets, and high resolution light microscopes.
**Biochemical Laboratory** includes facilities for the maintenance of aerobic and anaerobic microorganisms, and for enzyme analysis.

**Bioconversion Laboratory** is equipped to monitor air quality, develop processing technology for solid waste conversion to composts, and evaluate the quality and safety characteristics of compost.

**The Bio-expression and Fermentation Facility** is housed within the Department of Biochemistry and is a molecular biology, protein and biomass production core facility.

**Biomass Processing Laboratory** includes preprocessing technologies such as pelleting, torrefaction, pyrolysis, solvent extraction, and hydrolysis, and includes conversion technologies such as pyrolysis, liquefaction, gasification, catalytic conversion, fermentation, and transesterification. A novel aspect of carbon cycling using bichar (a coproduct of pyrolysis) is being studied as a soil carbon sequestration method that simultaneously provides significant agronomic benefits.

**Biomechanics/Gait Analysis Laboratory** is designed to analyze motion of bodies and evaluate tissue mechanics.

**Bio-Photonics Laboratory** is involved in optical sensing and optical imaging using the visible light spectrum.

**Biorefining Research and Education Center (BREC)** hosts a pilot thermochemical biorefinery. The pilot scale refinery system converts peanut hulls to hydrogen (or other fuels) and produces a carbon char co-product, biochar. This byproduct in itself holds tremendous potential for carbon sequestration and soil amendments, which are currently being researched.

**Cellular Bio-Engineering Laboratory** is equipped for a study of enzyme and cell-based sensing. Current focus is on research towards use of nano/micro structures to facilitate the implementation of three-dimensional cultures in drug discovery programs.

**Clean Room** consists of a 500-square-foot microfabrication space equipped with fume hood, DI water, gases, vacuum, exhaust system, air filtration system and chemical storage. The major equipment inside clean room are one MJB3 mask aligner, one bench top chemical spinner and one bench top hot plate. It is designed to carry out fabrication processes for engineering and biomedical research.

**Fermentation Laboratory** is equipped for the growth of microorganisms and for the design of processes to optimize their use.

**Functional Nanomaterials Synthesis and Characterization Laboratory** is equipped with six well-controlled tube furnace synthesis systems, a field-emission gun scanning electron microscope attached with an energy-dispersive x-ray spectrometer, a spectrofluorometer, a UV-vis spectrometer and a variety of other nanomaterials synthesis equipment.

**Geographic Information Systems (GIS) Laboratory:** This laboratory contains workstations and PC’s, color plotters/printers/ high-quality scanners and a Calcomp digitizer to analyze spatial data. SPANS, Arc/Info, ArcView and ERDAS software packages are used in many applications to environmental engineering.
Materials Testing Laboratory is equipped for investigating the mechanical properties of both physical and biological materials undergoing static and dynamic loading.

MEMS Test and Characterization Laboratory (RBS) is designed to carry out the research work for microelectromechanical systems (MEMS) device fabrication, testing and characterization.

Microcontroller Laboratory houses stations for data acquisition, analog and digital signal applications and machine control.

Microscopy Laboratory is equipped with an Olympus IX71 inverted microscope and a variety of lasers, optics, and electro-optic components for research and development of advanced microscopy techniques.

Molecular Nano-bioengineering/Molecular Nano-bioelectronics Laboratory houses equipment to investigate organic molecules, especially biological systems on the single molecular level.

Office of the State Climatologist: Extensive weather and climate impact data and computer models are available for design to meet Georgia’s environmental conditions.

Optical Microscopy Laboratory: This laboratory is being developed to enable research into novel techniques for the advancement of optical microscopy and imaging.

Polymer Science and Engineering Laboratory (RBS) includes 1500 square feet of laboratories used to synthesize and characterize polymeric materials.

Processing Systems and Unit Operations Laboratory: This laboratory focuses on process and material properties measurements and physical and biological process studies for optimizing energy and environmental pollution abatement.

Research Shop: All basic metal and wood working equipment are available.

Tissue Biomechanics Laboratory is designed for activities in analyzing the loading behavior of soft and hard animal tissues as well as plant materials.

Virtual Experiences Laboratory is equipped for research on the use and development of virtual, mixed, and augmented reality experiences.

Water Quality Analysis Laboratory/Watershed Center houses labs for analyzing physical, chemical, and biological characteristics of water samples.

Watershed Assessment: Extensive research programs combining bioassessments, physical habitat assessments, water quality analysis and hydrologic modeling. This laboratory offers workstations and PC’s for use in GIS analysis and computer modeling.

B. Griffin Campus – Research Labs

Georgia Automated Weather Station Network and Agrometeorology Laboratory
Statewide Automated Environmental Monitoring Network (AEMN), consisting of over 58 automated weather stations that collect weather and other environmental variables on a
continuous basis (http://www.georgiaweather.net/). An instrument laboratory allows for evaluation and calibration of sensors, data loggers, and other environmental equipment.

**Crop Modeling Laboratory**
Hardware and software for the development and application of crop simulation models, decision support systems, and Geographic Information Systems (http://www.icasa.net/index.html).

**Envirotron**
Multi-disciplinary environmental control facility to study the interaction of environmental factors, including temperature, humidity, radiation, soil moisture, CO2, O3, and other trace gases, on plant growth and development. The facility currently includes nine large indoor growth chambers, eight greenhouses, and three movable controlled-environment sunlit growth chambers, and four rainout shelters.

**Electronics Laboratory**
Facilities and electronics equipment such as oscilloscopes, multimeters, and Labview software provide capabilities for developing sensors, instrumentation, data acquisition systems, and electronic devices needed for research, extension, and instruction programs.

**Food Engineering and Packaging Laboratory**
Facilities and electronics equipment such as oscilloscopes, multimeters, and Labview software provide capabilities for developing sensors, instrumentation, data acquisition systems, and electronic devices needed for research, extension, and instruction programs.

**Postharvest Systems Laboratory**
A pilot plant includes equipment for simulating commercial unit operations for fresh fruits and vegetables including: TEW packing line (wash, dry, inspect visually, wax and size), three walk-in coolers with four chambers in each with independent RH control, vibration table (transport simulation), two Kyser-Werner retail display cases and a home kitchen.

**C. Tifton Campus – Research Labs**

**Water Quality Laboratory**
Approximately 3,000 square feet of sample preparation and analysis space with modern instrumentation with NESPAL (http://nespal.cpes.peachnet.edu).

**Flexible Laboratory Spaces**
Available spaces can accommodate a wide variety of uses. These range in size and characteristics from 400 square feet of clean and conditioned space to 3,000 square feet enclosed, heated, high-clearance space or 2,000 square feet of covered exterior space.

10. **ADMINISTRATION**

Describe how the proposed program will be administered within the structure of the institution.
The program will be based in the Institute of The Faculty of Engineering. The Faculty of Engineering is a stand-alone academic unit which has a budget provided directly by the Provost. The overall responsibility will reside with the Director of the Faculty of Engineering who reports directly to the Provost. The Director will be the administrative officer of the program and will be responsible for budgetary and related business matters.

The Graduate Coordinator of the Faculty of Engineering will coordinate all academic aspects of this graduate degree program. Applications for admission will include academic records and evidence of earned B.S. degree in engineering or related sciences, GRE test scores, letters of recommendation and statement of purpose. The Graduate Committee will review all applications, and based on its recommendation, the Graduate Coordinator will recommend admission to the Graduate School Dean. The policies and procedures of the University of Georgia Graduate School will govern the administration of the program and the Dean of the Graduate School will certify the compliance by individual students with regard to the requirements for admission and graduation. The Graduate Coordinator will serve as the Chair of the Faculty of Engineering Graduate Committee. This committee will meet quarterly and each member will serve a three-year term and may be reappointed for no more than one consecutive three-year term. The general responsibility of the Graduate Committee will be to oversee all graduate degree programs to recommend guidelines and procedures for enhancing the quality of the programs. The Graduate Committee will be responsible for the following items and will make its recommendations to the Director of the Faculty of Engineering:

a. Guidelines for recruitment, admission and retention/dismissal.
b. Guidelines for assistantships
c. Guidelines for remedial programs to strengthen the background of students in complementary science(s).
d. Guidelines for uniformity of credits for courses.
f. Guidelines for all graduate degree examinations.
g. Guidelines for appointment of graduate advisory committees.
h. New instructional needs and course proposals.
i. Development of collaborative relationships with government research units and industry.
j. Guidelines on other matters ensuring continued program enhancement.

The Director of the Faculty of Engineering, in consultation with the Engineering Council, will act on the recommendations of the Graduate Committee.

11. ASSESSMENT

Indicate the measures that will be taken to assess the effectiveness of the program and the learning outcomes of students enrolled.

The effectiveness of the proposed degree will be assessed by the following methods:
A. Graduates of the program

The performance of graduates of this degree program will be monitored by collecting information on:

i. Employment opportunities

Number of offers received
Geographic distribution of offers
Distribution of industries offering employment
Type of position obtained
Starting salary
Unemployment
Underemployment
Advancements in position and salary after five years

ii. Additional Graduate Studies

Graduate school enrollment
Nature of graduate programs enrolled
Professional school enrollment (e.g. M.D.)

iii. Other

Graduates starting new companies
Consulting areas

B. Recruitment and Enrollment

The success of this program will be assessed by the impact on recruitment and enrollment:

i. Number and quality of applicants

GRE scores
Geographic distribution of applicants
Undergraduate grade point average
Distribution of disciplines represented in applicants

ii. Number and quality of applicants from underrepresented groups

C. Performance of Enrolled Students

The performance of students in this program will be assessed by:

i. Overall grade point average

ii. Grades in non-engineering courses (Sciences, Mathematics)

iii. Percent completing degree and time to completion

iv. Scholarships and fellowships awarded

v. Publications in journals

vi. Other recognized tests (e.g., MCAT, GRE)

vii. Scholarly presentations

D. Impact of Enrolled Students

The impact of students enrolled in this program will be assessed by:

i. Departmental, College, Institute and University awards provided to enrolled students

ii. Activities of enrolled students in professional societies

iii. Activities of enrolled students in student organizations

iv. Patent applications of enrolled students
E. Regional and National Standing of the Program

The regional and national standing of the program will be assessed by:

i. Faculty/students invited to consult with other universities

ii. Faculty/students retained as consultants by pharmaceutical and biobased industries

iii. National demand for graduates, assessed from data shared among engineering deans and from the number of faculty and industry positions advertised

iv. Regional and national awards to faculty and students

v. Regional and national media descriptions

12. ACCREDITATION

Identify accrediting agencies and, where applicable, show how the program meets the criteria of these agencies.

The accrediting agency for professional engineering degree programs in the United States is ABET. ABET allows an institution to seek accreditation for a program at only one degree level – B.S., M.S. or Ph.D. The University of Georgia only seeks accreditation for undergraduate engineering degree programs which is the guideline used by most universities for engineering degree programs. Thus, accreditation for this degree program will not be sought.

13. AFFIRMATIVE ACTION IMPACT

Indicate what impact the implementation of the proposed program will have on the institution’s desegregation and affirmative action programs.

The degree program will be open to all qualified persons and shall not discriminate on the basis of race, color, religion, national origin, sex, age, or physical disability. The engineering program at the University of Georgia has focused effort in recruiting students and faculty from under-represented groups and is a charter member of the Southeastern Consortium for Minorities in Engineering (SECME). In addition to continued active participation in SECME, engineering recruiting activities include participation in identifying students in the under-represented populations through letters, personal contacts and visitations. The University has agreements with several HBCU’s and the proposed engineering program in Biochemical Engineering is expected to enhance the effectiveness of these agreements, especially with institutions having established colleges of engineering. The graduate degree program will also foster research collaborations that provide opportunities for graduate student and faculty exchange. It is anticipated that strong biological emphasis in the engineering program will be appealing to students from a broad spectrum of engineering and biological interests. It is expected that this program will enhance minority recruitment and will contribute to the University’s goal of increasing enrollment from the under-represented groups.

14. DEGREE INSCRIPTION

Indicate the degree inscription that will be placed on the student’s diploma upon completion of this program of study.
Doctor of Philosophy with major in Engineering

15. FISCAL AND ENROLLMENT IMPACT AND ESTIMATED BUDGET

On this form please indicate the expected EFT and headcount student enrollment, estimated expenditures, and projected revenues for the first three years of the program. Include both the reallocation of existing resources and anticipated or requested new resources. Second and third year estimates should be in constant dollars – do not allow for inflationary adjustments or anticipated pay increases. Include a budget narrative that explains significant line items and discusses specific reallocations envisioned.

<table>
<thead>
<tr>
<th></th>
<th>FY12 First Year</th>
<th>FY13 Second Year</th>
<th>FY14 Third Year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENROLLMENT PROJECTIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(indicate basis for projections in narrative)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A. Student majors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Shifted from other programs</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2. New to institution</td>
<td>3</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>Total Majors</td>
<td>5</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td><strong>B. Course sections satisfying program requirements.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Previously existing</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>2. New</td>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total Program Course Sections</strong></td>
<td>14</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td><strong>C. Credit Hours generated by those courses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Existing enrollments</td>
<td>288</td>
<td>288</td>
<td>288</td>
</tr>
<tr>
<td>2. New enrollments</td>
<td>48</td>
<td>150</td>
<td>288</td>
</tr>
<tr>
<td><strong>Total Credit Hours</strong></td>
<td>336</td>
<td>338</td>
<td>568</td>
</tr>
<tr>
<td><strong>D. Degrees awarded</strong></td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>(yr 2)</td>
<td>(yr 3)</td>
<td>(yr 4)</td>
<td></td>
</tr>
</tbody>
</table>

II. COSTS

<table>
<thead>
<tr>
<th></th>
<th>EFT Dollars</th>
<th>EFT Dollars</th>
<th>EFT Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personnel–reassigned or existing positions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Faculty</td>
<td>0.5</td>
<td>40,000</td>
<td>1.0</td>
</tr>
<tr>
<td>2. Part-time Fac.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Grad. Assist.</td>
<td>1.0</td>
<td>30,000</td>
<td>1.5</td>
</tr>
<tr>
<td>4. Administrators</td>
<td>0.10</td>
<td>10,000</td>
<td>0.10</td>
</tr>
<tr>
<td>5. Support staff</td>
<td>0.3</td>
<td>7,500</td>
<td>0.5</td>
</tr>
<tr>
<td>6. Fringe benefits</td>
<td>0.125</td>
<td>19,125</td>
<td>0.125</td>
</tr>
<tr>
<td>7. Other personnel costs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total Existing Personnel Costs</td>
<td>106,625</td>
<td>181,125</td>
<td>343,625</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>EFT Dollars</th>
<th>EFT Dollars</th>
<th>EFT Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personnel–new positions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Faculty</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2. Part-time Fac.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Grad. Assist.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. Administrators</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5. Support staff</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6. Fringe benefits</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7. Other personnel costs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Page 27 of 74
### Total New Personnel Costs

<table>
<thead>
<tr>
<th></th>
<th>FIRST YEAR</th>
<th>SECOND YEAR</th>
<th>THIRD YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### C. Start-up Costs (one-time expenses)

1. Library/learning resources: 2,000
2. Equipment: 280,000
3. Other: 0

### D. Physical Facilities: construction or major renovation

<table>
<thead>
<tr>
<th></th>
<th>FIRST YEAR</th>
<th>SECOND YEAR</th>
<th>THIRD YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>65,000</td>
<td>66,000</td>
<td>48,000</td>
</tr>
</tbody>
</table>

**TOTAL ONE-TIME COSTS**: 347,000

### E. Operating Costs (recurring costs–base budget)

1. Supplies/Expenses: 3,000
2. Travel: 500
3. Equipment: 6,000
4. Library/learning resources: 500
5. Other: 0

**TOTAL RECURRING COSTS**: 10,000

**GRAND TOTAL COSTS**: 463,625

### III. REVENUE SOURCES

#### A. Source of Funds

1. Reallocation of existing funds: 412,553
2. New student workload: xxxxxxxxxx
3. New tuition: 51,072
4. Federal funds: 0
5. Other grants: 0
6. Student fees: 0
7. Other: 0

**Subtotal**: 60,947

**New state allocation requested**: 0

**GRAND TOTAL REVENUES**: 463,625

#### B. Nature of funds

1. Base budget: 116,625
2. One-time funds: 347,000

**GRAND TOTAL REVENUES**: 463,625

### Budget Narrative
In November 2010, the Board of Regents approved the University of Georgia proposals for BS degrees in civil, electrical and electronics, and mechanical engineering and their associated budgets. The resources allocated for those three BS degree programs also provide the faculty, staff and other resources required to implement this PhD in Engineering degree program. Thus, no new resources are needed for this degree program.

The above budget is required for implementation of the Ph.D. in Engineering degree program. A similar budget is presented in the companion M.S. in Engineering degree program proposal. Upon the approval and funding of the Ph.D. in Engineering proposal, the resources requested above will also fulfill the budgetary requirements for implementation of the companion M.S. in Engineering degree program.

APPENDIX A

Graduate Course Descriptions
Course Descriptions for Existing Engineering Courses:

**ENGR 6910. Research Methods.** The philosophy of engineering research, research methodology, review of the departmental research programs, and writing and presenting thesis and dissertation proposals and grant proposals.

**ENGR 6101. Computational Mathematics for Engineers: Fundamentals.** The use of computational applied mathematics techniques to develop models to evaluate data and make predictions of relevance to engineering. Numerical differentiation and integration, Taylor series, numerical solutions of ordinary differential equations and programming techniques are examined in the context of engineering applications.


**ENGR 8950. Graduate Seminar.** Presentations/discussions related to engineering research, teaching, design, and service presented by students, faculty, and industry leaders.

**ENGR 8160. Advanced Fluid Mechanics.** A mathematical treatment of fluid mechanics using tensors with emphasis on viscosity, momentum balance in laminar flow, equations of change, velocity distribution in laminar and turbulent flow, interphase transport, macroscopic balance, and polymeric liquids. Analytical and numeric methods for solving fluid mechanic problems will be used.

**ENGR 8170. Advanced Heat Transfer.** Conduction, convection, and radiation heat transfer will be covered from an analytical and applications viewpoint. Computer tools for solving heat transfer problems will be emphasized. Projects will involve the analyses of a research-related or design-related heat transfer problem involving at least two of the three heat transfer modalities.

**ENGR 8180. Advanced Mass Transfer.** Basic laws of mass transport will be derived. Advanced mass transport will focus on molar flux, Fick's law, binary diffusion, two phase transfer, convective mass transfer, mass transfer coefficients, and mass transfer with chemical reaction. A project will be assigned requiring numerical solution of governing mass transport equations.


**ENGR 4510/6510. Biochemical Engineering.** Design and analysis of enzymatic and microbial biological reaction systems.

**ENGR 4520/6520. Design of Biochemical Separations Processes.** Unit operations used for biological processing including filtration, centrifugation, cell disruption, isolation, purification, and polishing.

**ENGR 6530. Monitoring and Control of Biological Processes.** Concepts of biological process controls; modern control techniques and optimization of batch, fed-batch and continuous bioreactors, and other biological systems.

Formal Proposal for Ph.D. in Engineering

ENGR 4250/6250. Advanced Microcontrollers. Using the MC68HC11 to solve practical engineering monitoring and control problems. A project-oriented course.

CSCI(ENGR) 8940. Computational Intelligence. Programs that solve complex problems in a particular domain, typically independent of knowledge used to direct the search for an optimal solution. Approaches include simulated annealing, genetic algorithms, neural networks.

ENGR 6410. Open Channel Hydraulics and Sediment Transport. Fundamental mass, energy, and momentum transport relations in water flows open to the atmosphere. Channel design and measurement of flows in natural channel. Sediment transport relations are introduced.

ENGR 4440/6440. Environmental Engineering Unit Operations. Engineering science and design related to treatment of drinking water and wastewater as well as the treatment and ultimate disposal of the sludges created during water treatment.

ENGR 4450/6450. Environmental Engineering Remediation Design. Engineering science and design related to environmental modeling, solid waste management, and hazardous waste management. Concepts of risk assessment will also be introduced.

ENGR 8580. Compost Facility Engineering. Factors impacting the design and operation of large scale composting facilities.

ENGR 8310. MEMS Design. Exploration of the world of microelectromechanical systems (MEMS) through awareness of material properties, microfabrication technologies, structural behavior, sensing techniques, actuation schemes, fluid behavior, electronic circuits, and feedback systems. Lectures will be augmented with homework assignments and design projects.

ENGR 8930. System Simulation and Optimization. A continuation of Introductory System Modeling. More advanced topics in this course are presented: combined discrete/continuous models, system parameter estimation, system optimization (discrete/continuous, unconstrained/constrained). Emphases will be on appropriate applications rather than mathematical optimization theories, with the goal of process analysis and improvement.


ENGR 4740/6740. Biomaterials. Biomaterials and groundwork for topics such as mechanical, chemical, and thermal properties of replacement materials and tissues. Implantation of materials in the body is studied for the biological point of view.

ENGG 8110. Mathematical Biology. Focus on mathematical topics used to model biological systems, and the corresponding biological applications. Problems related to population biology, biochemical pathways, enzymatic reactions, gene regulation, and systems biology will be discussed.

ENVE 8110. Ecological Energetics. Ecological thermodynamics analyses as applied to ecosystems. First law energy balances and second law entropy generation analyses of ecosystem scale problems will be covered through conventional thermodynamic approaches, a new Lagrangian-based analyses approach, and the Odum Energy approach to thermodynamics.

ENGG(CHEM) 4615/6615. Soft Materials. Introduction to soft condensed matter, including the general aspects of chemistry, physical properties, structure and dynamics, and
applications of soft materials (including polymers, colloids, liquid crystals, amphiphiles, gels, and biomaterials). Emphasis is placed on the molecular forces related to self-assembly.

Course Descriptions for Existing Courses in Other Departments:

**ADSC 6110-6110L. Experimental Methods in Animal Biotechnology.** Laboratory methods in molecular biology stressing recombinant DNA techniques. Experiments will include recombination, cloning, restriction analysis techniques, and optional experiments chosen by students.

**BCMB 6000. General Biochemistry and Molecular Biology.** Beginning intensive one-semester graduate-level course in biochemistry and molecular biology covering the structure and function of biological molecules, enzymology, metabolism, bioenergetics, and recombinant DNA technology.

**BCMB 8010. Advanced Biochemistry and Molecular Biology I.** Advanced biochemistry and molecular biology stressing thermodynamic principles in biochemistry, structural biology, enzymology, and aspects of metabolism and bioenergetics.

**STAT 8200. Design of Experiments for Research Workers.** Methods for constructing and analyzing designed experiments are considered. Concepts of experimental unit, randomization, blocking, replication, and orthogonal contrasts are introduced. Designs include completely randomized design, randomized complete block design, Latin squares design, split-plot design, repeated measures design, and factorial and fractional factorial designs.

**CSCI 8060. Advanced Software Engineering.** Analysis of advanced methods in software engineering. Emphasis is placed on formal specification methods, advanced software testing, software reuse, distributed software design, and communication protocol specification. Studies include advanced software development tools and systems.

**CSCI 8470. Advanced Algorithms.** Further study of fundamental algorithms. Topics covered include advanced data structures, graph algorithms, string algorithms, geometric algorithms, parallel algorithms, and approximation algorithms for NP-complete problems.

**CSCI 4810/6810. Computer Graphics.** Principles of two-dimensional and three-dimensional interactive raster graphics. Principles of scan conversion algorithms for two-dimensional and three-dimensional graphics primitives; data structures and modeling techniques for raster graphics; interaction, visual realism, animation and user interface design; ray tracing, illumination, shading, data storage/retrieval, software engineering and parallel computing for graphics.

**STAT 6310. Statistical Analysis I.** Basic statistical analysis for students in quantitative disciplines other than statistics. Topics include principles of sampling and descriptive statistics, elementary probability and probability distributions, discrete and continuous random variables, normal distribution, sampling distributions, statistical inference for one and two samples, simple linear regression, basic nonparametrics, and chi-squared tests.

**ECON 4400/6400. Economics of Public and Regulated Enterprises.** The economic analysis of regulated and nationalized industries and organizations, with emphasis on the regulation of electric, natural gas, and telecommunications enterprises. Methods and implications of privatization of traditionally "public" enterprises are also considered.

**ERSH 8310. Applied Analysis of Variance Methods in Education.** Experimental design and the analysis of data from experiments, including orthogonal analysis of variance for single and multifactor designs, randomized block, repeated measures, and mixed models. Computer applications and the reporting results using APA style.

**EPSY 6800. Foundations of Cognition for Education.** Cognitive psychology as applied to education. Cognitive theories, models, and processes are applied to the teaching and learning of school skills and content areas. Processes such as attention, critical thinking,
concept formation, language, memory, and problem solving are examined. Cognitive psychology principles are used to examine and refine instructional methods.

**BIOS(STAT) 8220. Clinical Trials.** Drug development and NDA approval procedures; randomization; blindness; phase I-IV clinical trials; multicenter trials; bioequivalency; sample size determination; design and analysis; cross-over design; repeated measurements design; survival analysis; meta analysis.

**ECOL 8220. Stream Ecology.** Current topics and literature from the standpoints of objectives, experimental design, data analyses, results, assessment of results, and significance to general stream ecology.

**ECOL 8230. Lake Ecology.** Current topics and literature in the ecology of lakes, ponds, reservoirs, and wetlands.

**CBIO 8050-8050L. Techniques in Modern Microscopy.** Modern microscopical techniques: brightfield, phase, DIC, fluorescence, confocal, scanning tunneling, and scanning and transmission electron microscopy. Related techniques: X-ray microanalysis photomicrography, and image analysis and processing.

**STAT 8200. Design of Experiments for Research Workers.** Methods for constructing and analyzing designed experiments are considered. Concepts of experimental unit, randomization, blocking, replication, and orthogonal contrasts are introduced. Designs include completely randomized design, randomized complete block design, Latin squares design, split-plot design, repeated measures design, and factorial and fractional factorial designs.

**VPHY 8960. Molecular Toxicology.** Molecular mechanisms of toxicities.

**BCMB(BINF) 8210. Computational Methods in Bioinformatics.** Computational methods, including development and implementation of computer codes, used to solve biological problems; development and solution of statistical and mathematical biological models. Topics include bio-sequence comparison and analysis, functional site prediction, structure prediction and analysis, and biological data analysis.

**Course Descriptions for New Courses**

**ENGR 8910 Design and Research Methods (3-hr).** Modify the current Research Methods course ENGR 6910 by adding a module for teaching design methodology with a short-term design project.

**ENGG 8XX1/2 Technology Based Entrepreneurship (2-hr).** The course provides a broad practice-based experience in the process of creating new products. It starts with the idea generation process and ends with plans for the commercialization of new products. The pedagogical objectives are to shape student abilities to think about technology-based business creation, evaluation of situations from a strategic perspective, and reaching strategic decisions. Accomplishing these objectives entails introducing students to how an enterprise must deal with all complexities and constraints of the environment in which it operates, why none of these can be assumed away or ignored, and how situation factors impact strategic decisions. Topics covered include but are not limited to: starting, financing, and managing a technology-based business as well as management of existing enterprises; market analysis; product design specification; proposal preparation; strategic management; manufacturing facilities design; and business plan.

**ENGG 8XX1 Effective Engineering Teaching Studio (1-2-hr).** In this studio, students will develop effective teaching strategies of active and cooperative learning, course planning, assessment of student learning, student learning styles, and strategies for becoming a good educator while still meeting other requirements of a graduate student or new faculty member. Students will be required to keep an online teaching portfolio.
Formal Proposal for Ph.D. in Engineering

(including written reflections with at least one new reference per week from a journal article), observe courses, and teach a portion of a course to peers. Students in the Practicum in Engineering Education Teaching course will meet during the same time period, which will provide opportunities for peer mentoring among students.  

Contact time: 3 hours per week

**ENGG 8XX2  Practicum in Engineering Teaching (1-hr).** In this studio, students will attend weekly studio sessions for one and a half hours to reflect on their teaching experiences and will be required to have a separate teaching assistantship (TA) position. Students will be required to design and teach at least three classes throughout the semester for their TA position. This will provide opportunities for students to learn from prior experience and integrate new concepts learned into their teaching. Students will continue their online teaching portfolios which will include weekly written reflections documenting progress towards becoming an effective engineering educator.

**ENGG 8XXX  Advanced Nanoelectronics (3-hr).** This course will cover the following: (1) Classic and current research and theories about electronic transport in nanoscale structures; (2) Major experimental approaches used to measure the electronic, optical, and mechanical properties of nanostructures; (3) Differences in electronic transport behaviors when structure size shrinks to nanoscale; and (4) Quantum transport. The course will also cover methods to search and read scientific papers and design research projects to address important problems in nanoelectronics.

**ENGG 8XXX  Tissue Engineering for Drug Discovery (3-hr.).** Advances in cell-surface interactions for physiologically relevant three-dimensional cell-based sensors and microtissue formation in vitro and signal readout technologies. Emphasis is on applications in drug discovery and pre-clinical development.

APPENDIX B
Scholarship, Publications and Professional Activities

of the Faculty Directly Involved

a. Name, rank, academic discipline, institutions attended, degrees earned

Mark A. Haidekker
Associate Professor, Faculty of Engineering

Postdoctoral (1999-2002), University of California, San Diego: Biomegineering
Ph.D. 1998 University of Bremen (Germany): Computer Science
Diploma¹ 1990 University of Hannover (Germany): Electrical Engineering

¹ The German university diploma is a 5-year professional degree that culminates in a research-based thesis and is generally considered equivalent to the M.Sc. degree

b. Current workload for typical semester, including specific courses actually taught

ENGG 4620/6620 Biomedical Imaging
Fall 2007 (as ENGR4980/8980), 2008 (as ENGR4620/6620), 2009

ENGR 4220/6220 Feedback Controls
Spring 2008, 2009

ENGR 8980 Advanced Topics
Summer 2008
Fall 2008

c. Scholarship and publication record for past five years

Haidekker MA. Advanced Biomedical Image Analysis (monograph). John Wiley & Sons, planned publication 2010


LaCroix JT, Haidekker MA. Quantifying light scattering with single-mode fiber-optic confocal microscopy BMC Medical Imaging (in press)


Nipper ME, Majd S, Mayer, M, Lee JCM, Theodorakis EA, Haidekker MA. Characterization of changes in the viscosity of lipid membranes with the molecular rotor FCVJ. Biochim Biophys Acta (Biomembranes) 2008; 1778: 1148-1153.


d. Professional activity

American Society for Engineering Education (institutional membership)
Biomedical Engineering Society
Institute for Biological Engineering
Sigma Xi, the Research Honors Society

e. Expected responsibilities in this program

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

a. Name, rank, academic discipline, institutions attended, degrees earned

Jenna R. Jambeck
Assistant Professor, Faculty of Engineering

Ph.D. 2004 University of Florida, Environmental Engineering Sciences
M.S. 1998 University of Florida, Environmental Engineering Sciences
B.S. 1996 University of Florida, Environmental Engineering Sciences

b. Current workload for typical semester, including specific courses actually taught

ENVE 2320 Environmental Engineering Urban Systems
Fall 2009, 2010

ENVE 3510 Statistics, Modeling and Uncertainty
Spring 2010

ENVE 4530 Energy and Environmental Policy Analysis
Fall 2010

c. **Scholarship and publication record for past five years**


d. **Professional activity**

Solid Waste Association of North America

e. **Expected responsibilities in this program**

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

---

a. **Name, rank, academic discipline, institutions attended, degrees earned**

caner Kazanci
Asst. Professor, Department of Mathematics
Member, Faculty of Engineering

- Ph.D. 2005 Carnegie Mellon University, Mathematical Sciences
- M.S. 2000 Carnegie Mellon University, Mathematical Sciences
- B.S. 1999 Bilkent University, Department of Mathematics

b. **Current workload for typical semester, including specific courses actually taught**

**MATH 2200 Calculus I**
Fall 2005

**MATH 2700 Differential Equations**
Spring 2008

**MATH 4500/6500 Numerical Analysis I**
Fall 2006

**MATH 4510/6510 Numerical Analysis II**
Spring 2007

**MATH 4700 Qualitative Differential Equations**
Fall 2009

**ENGR 6101 Computational Engineering: Introduction**
Fall 2008, 2009

**ENGR 8102 Computational Engineering: Elliptic Partial Differential Equations**

**ENGR 8103 Computational Engineering: Parabolic Partial Differential Equations**
ENGG 8110 Mathematical and Computational Biology  

MATH 8850 VIGRE Research Group  
Fall 2008, 2009  
Spring 2008

c. Scholarship and publication record for past five years


d. Professional activity

SMB, Society of Mathematical Biology
SIAM, Society of Industrial and Applied Mathematics
ISEM, International Society for Ecological Modeling

e. Expected responsibilities in this program

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

a. Name, rank, academic discipline, institutions attended, degrees earned

William S. Kisaalita
Professor, Department of Biological & Agricultural Engineering
Member, Faculty of Engineering

Ph.D. 1987 University of British Columbia, Chemical Engineering
M.A.S. 1982 University of British Columbia, Bioresource Engineering
B.S. 1978 Makerere University, Mechanical Engineering

b. Current workload for typical semester, including specific courses actually taught

ENGR 8980 Tissue Engineering for Drug Discovery
Fall  2007, 2009

ENGR 8950 Graduate Seminar

ENGR 4920 Engineering Design Project
Spring  1992 - 2008

ENGR 3720 Engineering Physiology

c. Scholarship and publication record for past five years


Yoder MF, Kisaalita WS. Fluorescence of pyoverdin in response to iron and other common well water metals. *J. of Environmental Science and Health Part A* 41:1-2, 2006


d. **Professional activity**

American Society for Engineering Education
American Chemical Society
American Association for Advancement of Science
Society for Biomolecular Sciences
American Society for Agricultural and Biological Engineering

e. **Expected responsibilities in this program**

Teach graduate level courses
Serve as major professor for M.S. and Ph.D. students
Serve on advisory committees for M.S. and Ph.D. students

a. **Name, rank, academic discipline, institutions attended, degrees earned**

Peter Kner
Assistant Professor, Department of Biological & Agricultural Engineering
Member, Faculty of Engineering

Ph.D. 1998 University of California, Berkeley, Physics
B.S. 1991 Massachusetts Institute of Technology, Physics
B.S. 1991 Massachusetts Institute of Technology, Electrical Engineering

b. **Current workload for typical semester, including specific courses actually taught**

**ENGR 4230 Sensors and Transducers**

Fall 2009 (1 sections)

**ENGR 1140 Computational Engineering Methods**

Spring 2010 (1 section)

c. **Scholarship and publication record for past five years**

P. Kner, J. W. Sedat, D. A. Agard, and Z. Kam, High-resolution wide-field microscopy with adaptive optics for spherical aberration correction and


P. Kner, B. B. Chhun, E. R. Griffis, L. Winoto, L. Shao, and M. G. L. Gustafsson, Live TIRF microscopy at 100nm resolution through structured illumination, *SPIE Photonics West*, San Jose, CA, January 2009


d. Professional activity

SPIE (Society of Photonics Engineers)
IEEE (Institute of Electrical Engineers)

e. Expected responsibilities in this program

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students
a. Name, rank, academic discipline, institutions attended, degrees earned

Kyle J. Johnsen
Asst. Professor, Faculty of Engineering
Ph.D. 2008, University of Florida, Computer Engineering
B.S. 2003, University of Florida, Computer Engineering

b. Current workload for typical semester, including specific courses actually taught

ENGR 1140 Computational Engineering Methods
Spring 2009
Fall 2009 (2 sections)
Spring 2010

ENGR 4920 Senior Design
Spring 2009 (The Data Analyzing Wireless Glove)

CSCI 6930 Virtual Reality
Spring 2010

c. Scholarship and publication record for past five years


B. Rossen, K. Johnsen, A. Deladisma, D. S. Lind, and B. Lok Virtual Humans Elicit Skin-Tone Bias Consistent with Real-World Skin-Tone Biases. Proceedings of Intelligent Virtual Agents, 2008


Raij, Andrew, Kyle Johnsen, Robert Dickerson, Benjamin Lok, Marc Cohen, Amy Stevens, Thomas Bernard, Christopher Oxendine, Peggy Wagner, D. Scott Lind


d. Professional activity

Member
 IEEE
 ACM

Program Committee
 IEEE Virtual Reality 2010
 ACM Virtual Reality Software and Technology 2009
 International Symposium on Mixed and Augmented Reality 2009

e. Expected responsibilities in this program

Teach undergraduate and graduate level courses
Formal Proposal for Ph.D. in Engineering

Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

a. **Name, rank, academic discipline, institutions attended, degrees earned**

Ke Li
Assistant Professor, Faculty of Engineering

Ph.D. 2003 Michigan Technological University, Environmental Engineering
M.S. 1998 Chinese Academy of Sciences, Environmental Chemistry
B.S. 1995 Tsinghua University, Environmental Engineering

b. **Current workload for typical semester, including specific courses actually taught**

ENVE 4550 Environmental Life Cycle Analysis
Spring 2010

ENVE 4620 Sustainable Design in Urban Systems
Fall 2010

c. **Scholarship and publication record for past five years**


Ke Li; P. Zhang; J. C. Crittenden; R. Kahhat; Y. Choi; D. Gerrity; H. Fernando; S. Guhatakurta; A. Sawhney; P. Torrens, 2009 Regional Futures 2100 (RF2100): A holistic framework for evaluating urban sustainability, in *Visualizing sustainable planning models*, Springer, Heidelberg.


Daisuke, M., K. Li, J. Crittenden, P. Westerhoff, 2008 Development of Group Contribution Method (GCM) for Hydroxyl Radical (HO•) Reaction Rate Constants in the aqueous phase, the 14th International Conference on Advanced Oxidation Technologies in San Diego, CA, Sept. 22.


Minakata, D.; Crittenden, J.C.; Li, K. 2007 Evaluation and design Advanced Oxidation Processes (AOPs). 1. UV/H$_2$O$_2$ processes for methyl tert -butyl ether (MtBE) and tertiary butyl alcohol (tBA) removal from drinking water source: effect of pretreatment options and light source. 2. Mitigation of bromate during ozonation –kinetic study -. *Water Quality Technology Conference Workshops Sun 5 Advanced Oxidation Technologies in Water. Nov. 4th, Charlotte, NC*.


American Association for the Advancement of Science Annual Meeting, San Francisco, CA, February 19.


d. Professional activity
American Environmental Engineering and Science Professors
American Chemical Society
Water Environment Federation
American Water Works Association

e. Expected responsibilities in this program
Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

_ a. Name, rank, academic discipline, institutions attended, degrees earned_

Jason Locklin
Assistant Professor, Department of Chemistry and Faculty of Engineering

Ph.D.  2004 University of Houston, Chemistry
B.S.   1999 Millsaps College, Chemistry

b. Current workload for typical semester, including specific courses actually taught

**ENGG 4165/6615; CHEM 4615/6615 Soft Materials**
Fall 2007, 2008, 2009

**CHEM 8390 Principles of Polymerization**
Spring 2008

**CHEM 2212 Organic Chemistry II**
Spring 2009, 2010

c. Scholarship and publication record for past three years


Samanta, S., J. Locklin. 2008. Formation of Photochromic Spiropyran Polymer Brushes via Surface-Initiated, Ring-Opening Metathesis Polymerization:


d. Professional activity

American Chemical Society
Materials Research Society
The Fiber Society
e. Expected responsibilities in this program

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

a. Name, rank, academic discipline, institutions attended, degrees earned
Sudhagar Mani
Asst. Professor, Biochemical Engineering Program, Faculty of Engineering
Asst. Professor, Department of Biological & Agricultural Engineering

Ph.D. 2005 University of British Columbia, Chemical Engineering
M.S. 2000 Indian Institute of Technology (IIT) Kharagpur – Food Engineering
B.E. 1998 Tamil Nadu Agricultural University, Agricultural Engineering

b. Current workload for typical semester, including specific courses actually taught

**ENGR 3140 Engineering Thermodynamics**
Fall 2007, 2008, 2009

**ENGR 3540 Physical Unit Operations**
Spring 2008, 2009

**ENGR 8520 Biomass Feedstock Engineering**
Spring 2008, 2009

**ENGR 8980 Process Modeling & Heterogeneous Catalysis**
Spring 2009

c. Scholarship and publication record for past five years


d. Professional activity

American Society of Agricultural & Biological Engineering (ASABE)
   (1) Chair, Georgia Section of ASABE (2009-2010)
   (2) Vice Chair, FPE 709 Technical Committee
   (3) Member, T-11 Energy Committee
   (4) Sub-task chair – Solid Fuels Standards development

American Institute of Chemical Engineers (AIChE)

Institute for Biological Engineers (IBE)
International Standards Organization (ISO)
(1) Task leader for working group 4 & 5 – Solid Biofuels Standard.

e. **Expected responsibilities in this program**

Teach undergraduate and graduate level courses
Sit on engineering graduate committees, serve in the Engineering Graduate Students Selection Committee and serve as major professor for M.S. and Ph.D. students

---

a. **Name, rank, academic discipline, institutions attended, degrees earned**

Leidong Mao  
Asst. Professor, Faculty of Engineering  
Ph.D. 2008 Yale University, Electrical Engineering  
B.S. 2001 Fudan University, Materials Science

b. **Current workload for typical semester, including specific courses actually taught**

**CSEE 2220 FUNDAMENTALS OF LOGIC DESIGN**  
Fall 2008, 2009

**ENGR 8310 MEMS DESIGN**  
Spring 2009

**FRES 1020 FRESHMAN SEMINAR**  
Fall 2009

c. **Scholarship and publication record for past five years**


d. **Professional activity**

Institute of Electrical and Electronics Engineers
American Society for Mechanical Engineers
American Chemical Society
e. **Expected responsibilities in this program**

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

---

a. **Name, rank, academic discipline, institutions attended, degrees earned**

Zhengwei Pan
Asst. Professor, Faculty of Engineering & Department of Physics and Astronomy

Ph.D. 1997 Northwestern Polytechnic University, China, Mater. Sci. & Eng.
M.S. 1993 Shandong University of Technology, China, Mater. Sci. & Eng.
B.S. 1990 Shandong University of Technology, China, Mater. Sci. & Eng.

b. **Current workload for typical semester, including specific courses actually taught**

**ENGR 4740/6740 Biomaterials**
Fall 2009

**ENGR 8980 Nanomaterials Characterization**
Spring 2008
c. Scholarship and publication record for past five years


Formal Proposal for Ph.D. in Engineering


d. Professional activity

Materials Research Society  
American Chemical Society  
TMS

e. Expected responsibilities in this program

Teach undergraduate and graduate level courses  
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

a. Name, rank, academic discipline, institutions attended, degrees earned

John R. Schramski  
Asst. Professor, Environmental Engineering, Faculty of Engineering  
Ph.D. 2006 University of Georgia, Ecology  
M.S. 1993 University of Cincinnati, Mechanical Engineering  
B.S. 1989 University of Florida, Mechanical Engineering

b. Current workload for typical semester, including specific courses actually taught

**ENGR 3160 Fluid Mechanics**  
Fall 1999  
Spring 1999  
Fall 2000

**ENGR 4300 Mechanical Systems II**  
Spring 2008

**ENVE 3210 Energy I**  
Fall 2009  
Fall2010 (scheduled)

**ENVE 3220 Energy II**  
Spring 2010 (scheduled)

**ENVE 4230 Ecosystem Energetics**  
Fall 2010 (scheduled)

c. Scholarship and publication record for past five years


d. **Professional activity**

International Society of Ecological Modellers
Georgia Professional Engineer, License #021404

e. **Expected responsibilities in this program**

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

**a. Name, rank, academic discipline, institutions attended, degrees earned**
Andrew T. Sornborger
Assoc. Professor, Faculty of Engineering, Department of Mathematics

Ph.D. 1995 Brown University, Physics
B.S. 1985 Dartmouth College, Computational Linguistics

b. Current workload for typical semester, including specific courses actually taught

**MATH2250 Calculus for Engineers and Scientists, Part I**
Fall 2004, 2008

**MATH2260 Calculus for Engineers and Scientists, Part II**
Spring 2005, 2006

**MATH2700 Ordinary Differential Equations**
Spring 2004, 2009

**MATH3500 Linear Algebra**
Spring 2008

**MATH4700/6700 Qualitative Differential Equations**
Fall 2006

**MATH4500/6500 Numerical Analysis**
Spring 2007

**MATH4780/6780 Mathematical Biology**
Spring 2007

**MATH4900 Transforms, Topics in Mathematics**
Fall 2009

**MATH8850 VIGRE Cardiac Physiology Group**
Fall 2004, 2005
Spring 2004, 2005

**ENGR4980 Undergraduate Independent Study**
Fall 2005 Blake Windsor, Mouse Brain Imaging
Fall 2005 Amit Salkar, Mouse Brain Imaging

**ENGR6930 Experimental Methods for Engineers**
Spring 2004, 2006

**ENGR8980 Special Topics in Engineering, Mathematical Physiology**
Spring 2005

**ENGR8980 Graduate Independent Study**
Fall 2005 Prince Odame, Multivariate Imaging Data Analysis
Fall 2008 Judith Navick, Multivariate Statistical Analysis

c. Scholarship and publication record for past five years (reverse chronological order)


Formal Proposal for Ph.D. in Engineering


d. Professional activity

Society for Neuroscience
Society of Industrial and Applied Mathematicians
American Mathematical Society

e. Expected responsibilities in this program

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students

a. Name, rank, academic discipline, institutions attended, degrees earned
Ernest W. Tollner  
Professor, Department of Biological & Agricultural Engineering  
Member, Faculty of Engineering

Ph.D.  1980  Auburn University, Bio Systems Engineering  
MSAE  1974  University of Kentucky, Agricultural Engineering  
BSAE  1972  University of Kentucky, Agricultural Engineering

b. Current workload for typical semester, including specific courses actually taught

**ENGR 3420 Soil Mechanics**  
Every Spring

**ENGR 3440 Water Management**  
Every Spring

**ENGR 4210/6210 Linear Systems**  
Every Fall

**ENGR 4920 Senior Design**  
Spring 2001-Present

**ECOL 8710 Environmental Law Practicum**  
Spring 2008

**ENGR 8750 Advanced Heat Transfer**  
Spring 2008, 2009

c. Scholarship and publication record for past five years


van Donk, SJ; Tollner, EW; Steiner, JL, Soil temperature under a dormant bermudagrass mulch: Simulation and measurement. Transactions of the ASAE, 47 (1): 91-98 JAN-FEB 2004.


d. Professional activity

American Society for Engineering Education
American Society of Agric. and Biol. Engineers
Publication director Co-chair of International Water Quality Conference (Chile, 2009, Costa Rica, 2010).
Contributor to the Fundamentals of Engineering Exam development
 Contributor to the Agricultural PE exam development
Operating Engineer, UGA BAE-Physical Plant Composting yard

e. Expected responsibilities in this program

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students
Currently serving as FE Graduate Coordinator

a. Name, rank, academic discipline, institutions attended, degrees earned

Joachim Walther
Asst. Professor, Faculty of Engineering

Ph.D.  2008 University of Queensland (Australia), Engineering Education
Dipl.-Ing. 1998 University of Darmstadt (Germany), Mechanical Engineering

b. Current workload for typical semester, including specific courses actually taught

ENGR 1010 Synthesis and Design Studio
Fall  2009

ENGR 1020 Synthesis and Design Studio
Spring  2010

ENGR 2010 Synthesis and Design Studio
Spring 2010

c. Scholarship and publication record for past five years


d. Professional activity

American Society for Engineering Education

e. Expected responsibilities in this program

Teach undergraduate and graduate level courses
Sit on graduate committees and serve as major professor for M.S. and Ph.D. students