

Proposal for joint BS in Engineering and Computer Science and MS Degree Program In Bioengineering

(Approved by the College of Engineering and Computer Science Graduate Studies Committee at its 2/29/2012 meeting)

Introduction

Joint BS and MS programs in all Engineering and Computer Science disciplines already exist. It is proposed that similar option is granted to Bioengineering students as well.

Purpose

The proposal is for a joint BS degree program in any of the Engineering and Computer Science programs and MS in Bioengineering. The joint program is expected to take an approximate duration of five years. The basic idea is to allow 9 credits of graduate course work count in BS as well as in MS degree. This essentially takes away one semester of course work and offers an attractive option for enthusiastic students planning for their graduate education. This program is expected to help retain our brightest undergraduate students for continuing their MS degree. This may also persuade them to go for their doctoral education.

Eligibility requirements and process

- Students with a cumulative GPA of 3.25 or better at the end of their junior year are eligible to participate in this program.
- Students must retain a cumulative GPA of 3.25 by the time of graduation.
- Students participating in this joint degree program may opt for thesis or non-thesis option in their MS degree
- Students planning for thesis MS, need a letter of recommendation from their potential thesis advisor

Process

- At the end of every semester, a list of students eligible to participate in the joint BS/MS degree program will be generated based on their cumulative GPA of 3.25 or better at the end of their junior year
- These eligible students will be invited to apply for the joint BS/MS degree program
- The students who accept the invitation will be asked to formally apply for graduate admission at the beginning of their senior year.
- The admission to the joint BS/MS degree program must be completed at least one semester prior to the start of the MS degree program

- Eligible students, with the approval of their academic advisors, may begin taking graduate courses in their senior year that would apply to both their BS and MS degrees. This should be done in consultation with both the student's undergraduate advisor as well as the faculty advisor for the Bioengineering MS program. A maximum of 9 credits can be applied to both BS and MS degrees.
- A maximum of 6 credits of 4000-level elective courses from the College of Engineering and Computer Science can be counted for both the BS and MS programs.
- Students in the joint BS/MS degree program must maintain enrollment in order to remain in the joint BS/MS degree program.
- Students who are successful in completing their MS degree within one year after their BS degree, will be presented a certificate of recognition

Degree requirements

Students participating in this program must meet all the degree requirements including core courses, pre-requisites etc. The only exception in this program is counting 9 credits in both BS and MS degrees similar to other joint BS to MS programs in Engineering and Computer Science.

Benefits to the College

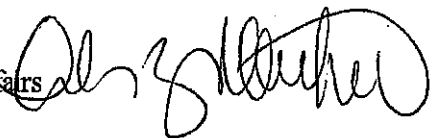
The proposed joint BS/MS degree program will help retain our brightest undergraduate students as graduate students. The program will certainly help counter the declining graduate enrollment. The program is also expected to help increase enrollment in our graduate courses and graduate degree production.



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MEMORANDUM

TO: University Graduate Program Committee

FROM: Ali Zilouchian, Associate Dean for Academic Affairs 

SUBJECT: Proposal for joint BS/MS in Bio-Engineering Program

DATE: March 15, 2012

Attached please find the proposal pertaining to joint BS in Engineering and Computer Science and MS in Bioengineering. The document was unanimously approved by the College Undergraduate Committee on February 29, 2012. The proposal has the full support of the College administration.



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First draft. It has not yet been discussed with the CEECS Department chair and with the COECS Dean.

Report on the FAU Bioengineering Program

March 18, 2012

I. History of the FAU Bioengineering Program

The FAU Bioengineering program commenced in Fall 2003 as a graduate certificate program building upon a collaboration between the College of Engineering and Computer Science (COECS) and the Schmidt College of Science. Academically the program was a COECS-wide program but administratively the program was placed in the Electrical Engineering Department. The program was primarily designed for engineers and scientists who were working (or planned to work) in the biotechnology, pharmaceutical, healthcare, drug discovery, and allied sectors. It was not a coincidence that the FAU Bioengineering Program was conceived around the time that Scripps moved to Florida. The certificate program consisted of a small menu of courses, from which students had to choose 3 courses in engineering and 2 in science. During the period of 2003-2008 more than 70 students were admitted to the certificate program, 11 of whom received the certificate.

By definition of any "certificate program", such has to rely on existing resources only. New Bioengineering courses were developed though by faculty members of some of the COECS engineering departments (primarily EE, CSE and ME) as investments of these departments in this new COECS venture. Administrative and clerical services were provided by the EE department (Dr. Sal Morgera who chaired the EE department, also became the director of the Bioengineering program. He and Drs. Roth and Neelakanta formed an Admissions Committee and Dr. Roth became the Faculty Advisor for the program).

A proposal to expand the certificate program into a MS degree program in Bioengineering was submitted by the Electrical Engineering Department, got approved in early 2008, and the first students were admitted in Fall 2008. It is important in a report like this to point out up front that unlike most other degree programs at FAU **the MS in Bioengineering program was launched with no start-up resources**: no faculty positions, no administrative and staff positions, no labs space and no start-up equipment budget. The only promised resource (which due to unforeseen terrible budget cuts that hit FAU later in that academic year never materialized) was Provost Pritchett's encouragement to Dr. Morgera to "go ahead and hire as many adjunct faculty as needed to develop a sound academic program". Academically the new MS program had to rely on courses developed earlier for the certificate program and again rely on engineering departments investment for new courses to be developed (of course not just for the Bioengineering Program). Administratively all arrangements made earlier for the certificate program were adopted for the MS program as well.

Due to the restructuring of the COECS in Summer 2009, the Bioengineering Program became administratively part of the CEECS Department (with Dr. Furht assuming leadership of the program and Dr. Roth, as part of his duties as Associate Chair of the CEECS department, continuing as Faculty Advisor and as a one man Admissions Committee).

Starting in Fall 2009 the CEECS department used its own limited resources to hire the first adjunct faculty for the Bioengineering Program (Mirjana Pavlovic, MD/PhD). The investment has so far paid off handsomely as Dr. Pavlovic's contributions to the program, courses and research wise, have become indispensable.

In Fall 2010 the CEECS department moved to its new place in the Engineering East building, and one of the CEECS department 11 research labs became a Bioengineering research lab. It is essentially a computer lab. The program still has no "wet labs".

Between Fall 2008 and Fall 2011, there were 34 applications to the MS program of which 23 students have been admitted, 9 of whom have graduated by Fall 2011 (four with a thesis option).

As of Spring 2012, there are 13 active students in the program, 4 of whom are expected to graduate in Spring 2012. The certificate program continues to exist on paper but only a handful of inquiries have come in recent years.

II. Faculty and Staff Associated with the Bioengineering Program

There are no faculty or staff members who "belong" to the Bioengineering Program, neither on a full-time basis nor as joint appointment with another program.

All bioengineering courses are presently taught by COECS regular faculty (primarily from the CEECS and OME departments: Drs. Neelakanta, Roth, Erdol, Rhodes, Khoshgoftaar, Zhu, Zhuang, Masory and Su) and by one adjunct faculty (Dr. Mirjana Pavlovic).

One CEECS faculty (Dr. Zvi Roth) provides student advising and students applications and admission services. Maintenance of students files and logistic services to Bioengineering students are provided by the CEECS Graduate Programs Coordinator (Ms. Jean Mangiaracina).

Dr. Roth also coordinates all curricular matters in consultation with the CEECS Bioengineering Committee, with ad-hoc COECS college-wide Bioengineering group of faculty, and by occasional contacts with faculty in the College of Science (most notably Drs. Narayanan and Binninger).

III. Bioengineering Program Academics – An Overview

Bioengineering stands at the intersection of the revolution taking place in advanced medical treatments as a result of applying the principles and practice of the engineering and computer science disciplines to the biological, biomedical and medical sciences. Bioengineering is a broad and emerging field that impacts drug delivery, surgery, diagnosis, prevention and treatment. Students successfully completing the Master of Science in Bioengineering degree program are expected to be prepared for professional careers in businesses related to medical diagnostics, prosthetic devices and neural and other implants; the pharmaceutical and biotechnology industries; and consulting in health-related fields, as well as other positions in industry, commerce, education and government. Students are also expected to be prepared to continue their formal education at the Ph.D. level in a variety of science and engineering disciplines and at the MD level in certain cases.

Admission requirements to the Bioengineering MS program (undergraduate GPA, GRE scores, TOEFL scores etc) are identical to those of any of the other COECS MS program. The big difference lies in the

wide spectrum of undergraduate disciplines of students who so far have been admitted to the program. Students may come from a Life Science background (with typical math education extending to Calculus 2 and with no computer programming background) or from engineering background (with typically only one course in chemistry, and no biology courses at all).

Several undergraduate courses were designated as deficiency courses. All engineering students must take PCB 3063 Genetics during their MS studies. A special agreement between the COECS and the College of Science allows bioengineering students to register to PCB 3063 skipping the Organic Chemistry and Biochemistry prerequisite courses. Incoming Life Science students are encouraged to take one of the COECS programming courses as a deficiency if they find the program core courses to be too hard on the programming side.

A set of core courses was created (12 credits altogether) designed to bring all incoming students to a reasonable "common denominator". The core courses consist of BME 5000 Introduction to Bioengineering, BME 5742 Bio-Systems Modeling and Control, EEL 6762 Bioinformatics: Bioengineering Perspectives and PCB 6935 Biotechnology Lab. Each of these courses is offered at least once a year.

In addition, a menu of courses which includes relevant engineering and science electives is updated every semester and is a tool to facilitate students' advising.

All non-thesis students are encouraged to take 3 credits of a DIS course in which they do a one-semester mini-research project under the guidance of one of the faculty associated with the Bioengineering Program.

IV. Bioengineering MS Program Enrollment and Graduation Data

The following table summarizes student enrollment and graduation figures from Fall 2008:

Semester	Enrolled	Graduated	Thesis / Non-Thesis
Fall 2008	3		
Spring 2009	4		
Summer 2009	4		
Fall 2009	7	1	Non-Thesis
Spring 2010	6		
Summer 2010	8	1	Thesis
Fall 2010	14	2	Non-Thesis
Spring 2011	14		
Summer 2011	15	2	1 Thesis; 1 Non-Thesis
Fall 2011	16	3	2 Thesis; 1 Non-Thesis
Spring 2012	13	4 (expected)	1 Thesis; 3 Non-Thesis

Summer 2012	11	1 (expected)	Non-Thesis
Totals		14	5 Thesis; 9 Non-Thesis

A partial post-graduation accounting of the 9 students who have graduated by Fall 2011: 2 went to medical schools, 2 went to PhD programs outside FAU, 2 went to PhD programs in FAU, 1 was hired by industry (and we are still trying to find out more about that company), 1 stayed at his employment place (Navy) and one of the students who graduated in Fall 2011 is probably still undecided what to do next. The following table summarizes the background disciplines of the students enrolled in the FAU Bioengineering Program revealing a surprising fact that the majority of students (around 60%) are coming to the Bioengineering Program from a Life Science background.

Semester	Biology	Chemistry	Other Science	Electrical Eng	Mechanical Eng	Computer Eng / Sc	Biomed	Other Eng
F 2008			1		1			1
Sp 2009	1		1		1			1
Su 2009	1		1		1			1
F 2009	4		1		1			1 graduating
Sp 2010	4		1		1			
Su 2010	4	1	1	1	1 graduating			
F 2010	8 (1 gradua)	1	1 graduating	3		1		
Sp 2011	8	1		3		1	1	
Su 2011	8 (1 graduat.)	1 graduating		4		1	1	
F 2011	8 (1 gradua)	1		4 (1 graduat.)	1	1 graduating	1	
Sp 2012	7 (3 gradu)	1		3 (1 graduat.)	(not enrolled)		2	

V. Enrollment Data of the Bioengineering Program Courses

In this report we look only at engineering and computer science courses which are part of the MS in bioengineering degree program. No analysis has been done about the science courses which are acceptable for the bioengineering program.

The two tables below look at enrollment trends in four courses having a course number that starts with BME, three of which are core courses in the Bioengineering Program. We look at enrollment figures from the date of inception (which in all cases happened when the certificate program was introduced). All the courses were designed to be appealing as general electives for students who may not necessarily be in the Bioengineering Program.

Bioengineering courses Fall 2003 – Summer 2008 (Certificate Program)

Course	F03	S04	R04	F04	S05	R05	F05	S06	R06	F06	S07	R07	F07	S08
BME 5000 Intro to BE (Morgera)	27			8			6				12			
BME 5742 Biosystems (Roth)		13			8				9		6			
BME 6762 Bioinformatics (Neelakanta)			26					6			7			8
BME 6572 Nanotechnology (Su)	35			24		16								27

Bioengineering courses Fall 2008 – Spring 2012 (MS Program)

Course	F08	S09	R09	F09	S10	R10	F10	S11	R11	F11	S12
BME 5000 Intro to BE (Pavlovic)					12			24			22
BME 5742 Biosystems (Roth)	6						12			12	
BME 6762 Bioinformatics (Neelakanta)				13			18			11	
BME 6572 Nanotechnology (Su)							34			38	

Comments:

- 1) There was a period during the years 2007-2009 that the BME 5000 Intro to Bioengineering course was offered only as a directed independent study option, due to Dr. Morgera's busy schedule. The course has been totally overhauled by Dr. Pavlovic, after Dr. Morgera left FAU. It is now taught every Spring semester and it shows healthy steady enrollment figures. It is a popular general graduate elective as well as general undergraduate senior elective.
- 2) The BME 5742 Biosystems Modeling and Control course had periods of irregular offerings correlating with Dr. Roth's 50% administrative duties as Director of the Florida-Israel Institute (that lasted from Fall 2005 till Fall 2008). In the last two years the course has been offered every Fall semester.
- 3) The course BME 6762 Bioinformatics: Bioengineering Perspectives has in recent years been offered regularly every Fall semester,
- 4) The BME 6572 Nanotechnology course is offered every Fall semester. Enrollment figures became good when the course began to be dually offered at the graduate and undergraduate levels.
- 5) No Bioengineering courses were offered in Summer 2008.

The following two tables summarize enrollment in elective courses offered in both the certificate and MS degree programs. Each row often accounts for more than course on the subject.

Bioengineering elective courses Fall 2003 – Spring 2008 (Certificate Program)

Course	F03	S04	R04	F04	S05	R05	F05	S06	R06	F06	S07	R07	F07	S08
Computer Vision and Image Processing (Zhuang, Marques)	6	30								14				9
Neural Networks (Pandya, Mahgoub, Neelakanta)	20+13		10		15	9				14	18		15	
Database Systems	52	33		24			21			31	23		32	31

(Solomon)													
Data Mining (Khoshgoftaar)	31			13			18			15		12	8
Robotics (Zhuang, Masory)			3							17			18
Biometrics			19			10						14	
Biosignals (Zhuang)													
Medical Imaging (Rhodes)									8				
Biomechanics (Su)		9											
Biofluids (Su)			15										

Bioengineering elective courses Fall 2008 – Spring 2012 (MS Program)

Course	F08	S09	R09	F09	S10	R10	F10	S11	R11	F11	S12
Computer Vision and Image Processing (Zhuang, Marques)		14					10+14	22+9			
Neural Networks (Pandya, Mahgoub, Neelakanta)	12										14
Database Systems (Solomon)	29	26			31		42	24	27		26
Data Mining (Khoshgoftaar)	15	16			19		9	30		20	14
Robotics (Zhuang, Masory)				24							10
Biometrics (Zhuang)		11									
Biosignal Processing (Erdol)								12			

Medical Imaging (Rhodes)				10			9				13
Biomechanics (Su)											
Biofluids (Su)											
Tissue Engineering (Pavlovic)							15			11	
Biomedical Control (Pajunen)					12						

Comments:

- 1) The CEECS department offers several courses on Database Systems and on Data Mining and Machine Learning. These courses have healthy enrollment relying the regular Computer Science or Engineering students. These courses serve as good elective options for Bioengineering students who are interested in the field of Bioinformatics. Some of the Data Mining courses even aimed specifically at Bioinformatics (Fall 2007, Fall 2010).
- 2) The robotics and image processing courses are important electives for students who are interested in aspects of neuroscience or drug discovery and biotechnology. A robotics course is offered at least once every two years, and likewise for the image processing courses.
- 3) The Tissue Engineering course was developed by Dr. Pavlovic as a direct follow-up course to Intro to Bioengineering. It is offered every Fall semester.
- 4) The Biosignal Processing course was specially developed by Dr. Erdol for the Bioengineering program. So far it was taught only once.
- 5) The Medical Imaging course was specially developed by Dr. Rhodes for the Bioengineering program. It is offered at least once every two years.

VI. Potential Opportunities

- 1) Many inquiries have been received in the last year by undergraduate top students interested in pursuing a Joint BS in an engineering or science field and MS in Bioengineering. A recent COECS Graduate Committee resolution involving the adding of Bioengineering to other COECS BS to MS programs is not yet approved by the University Graduate Studies Committee. Once approved, there is a potential for an enrollment increase.

- 2) The COECS Bioengineering Group has recently created a task force charged with revising the Bioengineering Program curriculum to make it more attractive to Mechanical, Ocean and Civil Engineering students. Such a college wide collaboration hold a key for further enrollment increases.
- 3) An on-going faculty search in the area of Assistive Technologies (currently a priority research area for FAU) has several Bioengineering researchers in the group of finalists. If one such faculty is hired it will be a big boost for the Bioengineering Program, curriculum wise and research wise.
- 4) Theoretically speaking, no Bioengineering program anywhere in the nation is better placed than the FAU Bioengineering program. However, in order to take full benefit of the huge resource presented by the presence of Scripps Florida, Max Planck Florida Institute, VGTI, Torrey Pines in our area, would require a full time Bioengineering Program Director.
- 5) The FAU MD/PhD program holds a key for a development of a future PhD program in Bioengineering. It is estimated that 10% of the MD/PhD students may become interested in pursuing their PhD in an engineering field.
- 6) The large FAU Pre-Med program hold a promise for a successful future BS program in Bioengineering. Among all COECS engineering programs Bioengineering will be the only realistic pre-med option for engineering students. It is estimated that 10% of the university pre-med students may opt for a BS degree in Bioengineering.
- 7) One of the elements of the so called "Jupiter Initiative", which is still on the drawing board, was a plan to center the Bioengineering Program on the FAU Jupiter campus. The proximity to Scripps and MPFI and the potential for finally creating research "wet" labs for the program are irresistibly attractive.
- 8) There was a discussion not too long ago to create a joint COECS-College of Science Weekend MS Program (modeled after the successful Computer Science MS program) building upon the Bioengineering and the Biotechnology programs. Such a weekend program can become an important income source for both programs.
- 9) The lack of Bioengineering "wet" labs really holds back many of the Bioengineering Program research initiatives. It is ironical that so much money has recently been spent by the COECS on renovation of the Engineering West building and specifically for creating architectural drawing for a conversion of the lab in Engineering West Room 262 to a new and modern

Biology for Engineers / Bioengineering / Environmental Studies lab. Plans for such lab were very detailed and comprehensive in terms of the needed equipment (due to the efforts of Drs. Dan Meeroff and Mirjana Pavlovic). It is sad to see this effort dissipating into nothing. The recent designation of Science and Engineering Room 150 as a hub for Assistive Technologies Research and Education may create a hope that a Bioengineering research lab becomes part of this suite of future labs.

VII. Potential Threats

1) The Bioengineering Program has been very "thin" in terms of its man power. It is very sensitive to availability (or lack of availability) of its participating faculty.

If, for example, for any reason, it becomes impossible to continue hiring Dr. Pavlovic, the impact on the program curriculum will be devastating.

As another example, it is yet for the COECS to feel the impact of Dr. Roth's 2012-2013 sabbatical leave on the administrative running of the program and on the instruction of one of the program's core courses.

2) As said earlier, the Bioengineering Program is ideally positioned geographically and strategically. The potential for strong research collaboration with our allies on the north is large but the opportunity has to be seized fast. Not cashing on it may result in an irreversible program's loss of credibility.

VIII. Summary

Even at times of budget cuts an investment sometimes may be the best course of action.

There is no doubt that the COECS views the Bioengineering Program as one of its best near future growth areas, and as a future independent engineering department.

The program needs full time faculty, full time director, wet lab space and equipment.