

 FLORIDA ATLANTIC UNIVERSITY	NEW/CHANGE PROGRAM REQUEST Graduate Programs	UGPC Approval _____ UFS Approval _____ Banner _____ Catalog _____
	Department Comp. and Electrical Eng and Comp. Science College Engineering and Computer Science	
Program Name Current name: MS in Bioengineering Change to: MS in Biomedical Engineering	<input type="checkbox"/> New Program* <input checked="" type="checkbox"/> Change Program*	Effective Date <i>(TERM & YEAR)</i> Spring 2021
<p>Please explain the requested change(s) and offer rationale below or on an attachment.</p> <p>This proposal requests to change the name of the program from MS in Bioengineering to MS in Biomedical Engineering. This change is driven by the research expertise and activity of our faculty in areas of biomaterials, tissue engineering, neuroengineering, medical image analysis, and smart health. The catalog change is attached.</p> <p>CIP code: 14.0501 "Bioengineering and Biomedical Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of biomedical and health systems and products such as integrated biomedical systems, instrumentation, medical information systems, artificial organs and prostheses, and health management and care delivery systems. Examples: [Cell and Tissue Engineering], [Neural Engineering], [Biomaterials Engineering] ."</p>		
<p><i>*All new programs and changes to existing programs must be accompanied by a catalog entry showing the new or proposed changes.</i></p>		
Faculty Contact/Email/Phone Hanqi Zhuang/zhuang@fau.edu/561-297-3413	Consult and list departments that may be affected by the change(s) and attach documentation Department of Biomedical Science	
Approved by Department Chair <u>Hanqi Zhuang</u> College Curriculum Chair <u>Francisco Presuel-Moreno</u> College Dean <u>M. Cardei</u> UGPC Chair _____ UGC Chair _____ Graduate College Dean _____ UFS President _____ Provost _____	Digitally signed by Hanqi Zhuang Date: 2020.10.06 19:10:46 -04'00' Digitally signed by Francisco Presuel-Moreno DN: cn=Francisco Presuel-Moreno, o=Florida Atlantic University, ou=Ocean and Mechanical Engineering, email=fpresuel@fau.edu, c=US Date: 2020.10.07 08:45:15 -04'00' Digitally signed by M. Cardei DN: cn=M. Cardei, o=Florida Atlantic University, ou=Engineering and Computer Science Date: 2020.10.11 19:26:18 -04'00'	Date _____ _____ 10/11/2020 _____ _____ _____ _____

Email this form and attachments to UGPC@fau.edu 10 days before the UGPC meeting.

Biomedical Engineering Bioengineering

Biomedical engineering 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. **Biomedical engineering Bioengineering** is a broad and emerging field that impacts drug delivery, surgery, diagnosis, prevention and treatment. Students successfully completing the Master of Science in **Biomedical engineering Bioengineering** degree program will 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 will also be prepared to continue their formal education at the Ph.D. level in a variety of science and engineering disciplines and at the M.D. level in certain cases.

Combined Bachelor of Science in any major in the College/ Master of Science with Major in Bioengineering Biomedical Engineering

Bachelor of Science candidates in any College of Engineering and Computer Science program with a cumulative GPA of at least 3.25 at the end of their junior year are eligible to apply to the combined program, which allows students to complete their bachelor's, as well as a master's in **Bioengineering Biomedical Engineering**, within approximately five years. After application and admittance to the graduate program at the beginning of their senior year, up to 9 credits of approved graduate-level courses (5000 level or higher) may be taken and counted toward both the B.S. and M.S. degrees as long as the combined program totals a minimum of 150 credits:

1. The student has met the minimum 120 credits for the bachelor's degree; and
2. The student has taken a minimum of 30 credits in 5000 level or higher courses for the master's program.

Students must retain a cumulative GPA of 3.25 by the time of graduation. Thesis and Non-Thesis options are available. See below for master's program admission and degree requirements.

Master of Science with Major in Biomedical Engineering Bioengineering

Admission Requirements

All applicants must submit GRE scores and official transcripts from all previous postsecondary institutions attended. Applicants for admission will be evaluated on an individual basis and must satisfy the following requirements. Students with non-engineering bachelor's degrees, click [here](#) for additional requirements.

1. International students from non-English-speaking countries must be proficient in written and spoken English as evidenced by a score of at least 500 (paper-based test) or 213 (computer-based test) or 79 (Internet-based test) on the Test of English as a Foreign Language (TOEFL) or a score of at least 6.0 on the International English Language Testing System (IELTS);
2. A baccalaureate degree in Biology, Chemistry, Physics, Computer Science or Engineering with a mathematics background through Calculus 2 or calculus with basic differential equations; *
3. A minimum GPA of 3.0 (of a possible 4.0 maximum) in Science, Mathematics and Engineering courses;
4. Submission of the Graduate Record Examination (GRE) score or the MCAT score is required. GRE scores more than five years old normally are not acceptable. The GRE requirement is waived for any student who has a baccalaureate degree from FAU's Department of Computer & Electrical Engineering and Computer Science with a GPA of at least 3.25 (out of a possible 4.0) in the last 60 credits attempted prior to graduation.

* Students whose backgrounds are not in the disciplines noted should expect to take additional coursework.

Submission of Plan of Study

Graduate students are required to submit a Plan of Study when they have completed between 9 and 15 credits of coursework with a minimum cumulative GPA of 3.0. A student may not register for thesis credits prior to submitting a Plan of Study.

Degree Requirements

Students must satisfy all of the University graduate requirements. In addition, the following specific degree requirements apply, depending on the choice of degree program:

Master of Science Degree Thesis Option (30 credits)

1. Requires 6 credits of orally defended thesis. The M.S. committee is chaired by the student's thesis advisor. The chair of the committee must be a graduate faculty member from any department within the College of Engineering and Computer Science.
2. Requires 24 credits of approved graduate coursework (5000 level or higher) of which 12 credits are program core courses and the remaining 12 credits are approved elective courses offered by the College of Engineering and Computer Science and the Charles E. Schmidt College of Science.
3. No 4000-level course is allowed toward the degree. Courses taken to make up for deficiencies will not be counted toward the degree.
4. Must complete one semester of CGS 5937, Graduate Seminar (0 credits) with grade of Satisfactory ("S").

Note: No more than 3 credits of directed independent study may be applied toward the master's degree with thesis option.

Master of Science Degree Non-Thesis Option (30 credits)

1. Requires 30 credits of approved coursework of which 12 credits are program core courses and the remaining 18 credits are approved elective courses offered by the College of Engineering and Computer Science and the Charles E. Schmidt College of Science.

Note: No more than 3 credits of directed independent study may be applied toward the master's degree non-thesis option.

2. No 4000-level course is allowed toward the degree. Courses taken to make up for deficiencies will not be counted toward the degree.

3. Must complete one semester of CGS 5937, Graduate Seminar (0 credits) with grade of Satisfactory ("S").

Deficiency Requirements in the M.S. in Bioengineering Biomedical Engineering Program

It is expected that students successfully complete a course in Genetics or Molecular Genetics (PCB 4522 or PCB 3063 at FAU or equivalent) at any time during their MSBE studies. The lack of this course will be considered a deficiency. Students are expected to take the necessary course during their course program as an extra load beyond the regular graduate coursework. A genetics course must be completed prior to enrollment into the Special Topics (Advanced Biotechnology Lab) core course.

Students who have had no computer programming coursework during their B.S. studies are required to take any undergraduate programming course (such as COP 2220, Introduction to Programming in C, to satisfy this deficiency. The requirement must be satisfied prior to taking any of the following core courses: BME 5742, Biosystems Modeling and Control or BME 6762, Bioinformatics: Bioengineering Perspectives.

Furthermore, an advisor's approval is required for students not having the required mathematics background.

Program Core Courses (12 credits)

Introduction to <u>Bioengineering Biomedical Engineering</u>	BME 5000
Biosystems Modeling and Control	BME 5742
Bioinformatics: <u>Bioengineering Biomedical</u> Perspectives	BME 6762
Special Topics (Advanced Biotechnology Lab)	BSC 6936

Deficiency Requirements (not counted in the total program credits)

Genetics	PCB 3063
Introduction to Programming in C	COP 2220

Electives

Thesis Option: 12 credits of elective courses as follows.

At least 9 credits from the Advising Sheet list of Engineering and Computer Science or Science Biomedical Engineering ~~Bioengineering~~ courses (such as Tissue Engineering, Stem Cell Engineering, Biomaterials, Introduction to Microfluidics and BioMEMS, Introduction to Robotics, NanoBiotechnology, Robotic Applications and Orthopedic Biomechanics, Medical Imaging, Bio-Signal Processing and Bioinformatics).

Up to 3 elective credits of approved Engineering and Computer Science or Science coursework may be added (courses such as Digital Signal Processing, Digital Image Processing, Machine Learning and Artificial Intelligence, Modern Control, Advanced Database Systems, Nanotechnology, Neuroscience 1 and 2, or a directed independent study course).

Non-Thesis Option: 18 credits of elective courses as follows.

At least 9 credits from the Advising Sheet of Engineering and Computer Science or Science Biomedical Engineering ~~Bioengineering~~ courses (such as Tissue Engineering, Stem Cell Engineering, Biomaterials, Introduction to Microfluidics and BioMEMS, Introduction to Robotics, NanoBiotechnology, Robotic Applications and Orthopedic Biomechanics, Medical Imaging, Bio-Signal Processing and Bioinformatics).

Up to 9 elective credits of approved Engineering and Computer Science or Science coursework may be added (courses such as Digital Signal Processing, Digital Image Processing, Machine Learning and Artificial Intelligence, Modern Control, Advanced Database Systems, Nanotechnology, Neuroscience 1 and 2, Immunology, Biology of Cancer, or an additional directed independent study course).

Up to 6 elective credits may be free elective courses (not included on the Biomedical Engineering ~~Bioengineering~~ Advising Sheet) subject to approval of the Biomedical Engineering ~~Bioengineering~~ Program Advisor.

Academic Justification

The Department of Computer and Electrical Engineering and Computer Science (CECS) in the College of Engineering and Computer Science (COECS) is proposing to change the name of the program from the MS in Bioengineering to the MS in Biomedical Engineering. The change of the program name does not involve a change of the CIP code. The CIP code of the program remains the same:

<https://nces.ed.gov/ipeds/cipcode/searchresults.aspx?v=56&aw=14.0501>

CIP Code 14.0501

" **Bioengineering and Biomedical Engineering.** *A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of biomedical and health systems and products such as integrated biomedical systems, instrumentation, medical information systems, artificial organs and prostheses, and health management and care delivery systems. Examples: [Cell and Tissue Engineering], [Neural Engineering], [Biomaterials Engineering]. "*

This change is driven by the research expertise and activity of our faculty in the areas of Biomedical Engineering such as biomaterials, biosensors, tissue engineering, neuroengineering, medical image analysis, and smart health. Faculty in the College of Engineering and Computer Science conduct research to develop technologies to improve healthcare. There are research projects focused on many diseases that impact the US population and some of the underdeveloped countries including Malaria, Zika, HIV, Covid-19 and Sickle Cell. Other research related to state of the art biorobotics innovations could truly impact the future of the handicapped population. Finally, our engineers are also trying to develop bone tissue and use tissue engineering techniques to cure cancer. Below are some relevant research grants in the College of Engineering and Computer Science in the areas of Biomedical Engineering:

Biomedical Engineering Research	PI	Source	Funds
CAREER: Development of a point-of-care platform for the detection of infectious viruses	Waseem Asghar	NSF	\$ 500,000.00
Implementing a novel multimode 3D retinal imaging system to investigate metabolism and vascular disruptions in diabetic retinopathy	Mahsa Ranji	NIH	\$ 444,993.00
The behavior of hemoglobin-based artificial oxygen carriers (AOCs) after entering blood circulation	Sarah Du	NSF	\$ 402,000.00
Placenta-on-a-Chip Sensing Platform to Study Malaria	Sarah Du	NIH	\$ 400,154.00
Development of an Artificial Hand Exhibit	Erik Engeberg	SFCSA	\$ 84,433.00
Virtual Neuroprosthesis: Restoring Autonomy	Erik Engeberg	NIH	\$ 1,441,000.00
Targeting cMyc in the control of Inflammation	Sarah Du	UM/NIH	\$ 72,716.00
Dexterous Robotic Manipulator for Semi-Auton	Erik Engeberg	FIU/DOE	\$ 160,000.00
Development of a 90 Days Expiration Dot	Mike Kim	TLTC	\$ 57,772.00
Autotherapy of craniofacial bone defects using immunomodulatory and cell-recruiting bioceramic scaffolds	Kevin Kang	NIH	\$ 142,892.00

Development of an in Vitro 3D Tumor Tissue Engineering Model for Esophageal Cancer	Kevin Kang	NIH	\$ 142,285.00
I/UCRC for Center for Health Organization Transformation	Ankur Agarwal	VAR-SOU	\$ 150,000.00
Development of a Middleware Framework for Medical Device Integration for Telemedicine	Ankur Agarwal	VAR-SOU	\$ 50,000.00
A Mobile Based Care Coordination System for Critical Care	Ankur Agarwal	VAR-SOU	\$ 100,000.00
FAU Site Phase-2: I/UCRC for Center for Health Organization Transformation	Ankur Agarwal	NSF	\$ 200,000.00
Development of a diagnostic assay for rapid detection and quantification of Zika virus	Waseem Asghar	FDOH	\$ 199,280.00
Medical image analysis using deep learning techniques	Oge Marques	VIS-SOU	\$ 59,000.00
Development of disposable and refrigeration-free microchip technology for CD4+ T cell counting	Waseem Asghar	NIH	\$ 459,580.00

From:Russ Ivy <IVY@fau.edu>
Sent:Thursday, October 22, 2020 11:47 AM
To:Mihaela Cardei <mcardei@fau.edu>
Cc:Stella Batalama <sbatalama@fau.edu>; Hanqi Zhuang <zhuang@fau.edu>
Subject:RE: MS in Biomedical Engineering (change of the program name)

Dear Dr. Cardei,

I have reviewed the documents you forwarded regarding the change in title from MS in Bioengineering to MS in Biomedical Engineering within the College of Computer Science and Engineering. The current CIP that you are using for the degree is 14.0501 and you indicate you will keep the same CIP with the title change. The description of that CIP from the DOE fully fits with the change you are proposing. We currently have permission from both BOG and SACSCOC to offer a Masters degree in that CIP, therefore this is not considered a new degree program and is merely an internal process. BOG and SACSCOC do not record the exact name we use for our degrees, so they will not need to be notified of this change if approved. The Provost's Office supports this request.

Russ Ivy

From:Mihaela Cardei <mcardei@fau.edu>
Sent:Tuesday, October 20, 2020 5:13 PM
To:Russ Ivy <IVY@fau.edu>
Cc:Stella Batalama <sbatalama@fau.edu>; Hanqi Zhuang <zhuang@fau.edu>
Subject:MS in Biomedical Engineering (change of the program name)

Hello Dr. Ivy,

The CEECS department is proposing to change the name of the program from MS in Bioengineering to MS in Biomedical Engineering. Both "Bioengineering" and "Biomedical Engineering" are using the same CIP Code 14.0501. The catalog change and a memo with academic justification are attached.

Could you please review the attached documents and let us know whether the Provost Office approves the name change? Also, I would like to confirm with you that since the CIP Code remains unchanged, we do not need BOG approval and we will submit the proposal for the program change locally to FAU.

Best regards,
Mihaela

From:Janet Robishaw <jrobishaw@health.fau.edu>
Sent:Tuesday, October 20, 2020 7:31 PM
To:Hanqi Zhuang <zhuang@fau.edu>
Cc:Mihaela Cardei <mcardei@fau.edu>
Subject:Re: Please help: Biomedical Engineering: Program and Course Title Changes

Good evening Hanqi,

Thank you for the thoughtful response, which will be forwarded-once again-to the Graduate Program Committee/Task Force. It is unlikely that they will have a response by Monday given the short timeline and the immediate request from the Provost to reschedule all graduate courses for Spring 2021. However, I will convey the urgency of your request.

By way of clarification to your email, this issue has nothing to do with the Department of Biomedical Science but rather the Graduate Program Committee/Task Force that is responsible for the degree program in Biomedical Science.

Best Regards,

Janet

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From:Hanqi Zhuang <zhuang@fau.edu>
Sent:Tuesday, October 20, 2020 7:11 PM
To:Janet Robishaw
Cc:Mihaela Cardei
Subject:Re: Please help: Biomedical Engineering: Program and Course Title Changes

Dear Dr. Robishaw,

Thank you for taking time to review our proposed name change to “Biomedical Engineering”. The academic justification for changing the name of our program is attached.

The biomedical engineering programs are very common in the colleges of Engineering across the nation. In Florida in particular, the following universities have programs in Biomedical Engineering: UF, UCF, FSU, FIU, and FAMU. Programs are approved following the specifications defined in the CIP codes. “Bioengineering” and “Biomedical Engineering” have the same **CIP code 14.0501**. The code "14" corresponds to "Engineering". Please see below the entry for the CIP Code 14.0501:

<https://nces.ed.gov/ipeds/cipcode/searchresults.aspx?y=56&aw=14.0501>

"Bioengineering and Biomedical Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of biomedical and health systems and products such as integrated biomedical systems, instrumentation, medical information systems, artificial organs and prostheses, and health

management and care delivery systems. Examples: [Cell and Tissue Engineering], [Neural Engineering], [Biomaterials Engineering]. "

University of Florida for example, offers both Biomedical Engineering programs housed in the College of Engineering as well as Biomedical Sciences programs housed in the College of Medicine. The existence of one program should not preclude the offering of the other. Please find below replies from our department to the specific comments given by the GPC of the Department of Biomedical Science:

Biomedical Science Comment 1: The name change will cause confusion for students interested in applying to the MS Biomedical Science program.

Engineering Reply: As described previously, Biomedical Engineering is the application of scientific methods. Many universities have courses both in biomedical science and biomedical engineering.

Biomedical Science Comment 2: The name change would create an apparent competition with our program and ongoing MS Biomedical Science courses that teach concepts of bioengineering including tissue regeneration and restorative medicine.

Engineering Reply: We would like to look at this in a synergistic way. The need for medical devices or medical engineering arises from questions raised in medicine. One cannot function without the other. Development of biomedical engineering courses will not weaken or confuse the student but will enhance and solidify the interrelated objectives of the two fields. As indicated previously, universities in the state and beyond offer Biomedical Engineering programs (College of Engineering) along with Biomedical Science programs (College of Medicine). In fact, the best Biomedical Engineering programs are from those universities that also have the best medical schools. They promote each other and collaborate in terms of research and education.

Biomedical Science Comment 3: The name Biomedical in the Department of Computer and Electrical Engineering and Computer Science could inhibit the ongoing development approval of Biomedical Regenerative Medicine courses in the College of Medicine.

Engineering Reply: We are not offering Biomedical Regenerative Medicine courses, therefore this should not be an issue. Furthermore, our department will support Biomedical Regenerative Medicine course proposals from the College of Medicine.

I hope that the replies from the CEECS department have addresses the concerns raised by the Department of Biomedical Science. Please let me know if you have additional comments or if you need additional clarifications. If I do not hear from you by Monday October 26th, I will assume that you have no objections.

Thank you!

Hanqi

Hanqi Zhuang, Ph.D.
Professor and Interim Chair
Department of Computer & Electrical Engineering & Computer Science
Florida Atlantic University
Boca Raton, FL 33431
561-297-3413

From:Janet Robishaw <jrobishaw@health.fau.edu>
Sent:Friday, October 16, 2020 1:18 PM
To:Hanqi Zhuang <zhuang@fau.edu>
Cc:Mihaela Cardei <mcardei@fau.edu>; Marc Kantorow <MKANTORO@health.fau.edu>
Subject:RE: Please help: Biomedical Engineering: Program and Course Title Changes

Hi Dr. Zhuang,

First and foremost, thank you for consulting with us. I forwarded your request to the Graduate Program Committee. They have serious concerns regarding the potentially negative impact on the existing Biomedical Science program. In the present form, there are concerns regarding rationale and justification for name change, the potential growth of the College of Medicine's proposed courses in regenerative medicine and related areas, and the potential confusion between the programs on the part of the students. Please review the attachment for further clarification and reach out with any questions.

Best Regards,

Janet

From:Hanqi Zhuang
Sent:Monday, October 12, 2020 3:57 PM
To:Janet Robishaw <jrobishaw@health.fau.edu>
Cc:Mihaela Cardei <mcardei@fau.edu>
Subject:Please help: Biomedical Engineering: Program and Course Title Changes

Dear Dr. Robishaw,

The Department of Computer and Electrical Engineering and Computer Science is proposing to change the name of its master's program from **MS in Bioengineering** to **MS in Biomedical Engineering**. We also propose to change the name of our graduate Certificate from Bioengineering to Biomedical Engineering.

Correspondingly, we also proposed to change the titles of two courses in these programs as follows: "BME 5000 Introduction to Bioengineering" will be changed to "BME 5000

Introduction to Biomedical Engineering", and "BME 6762 Bioinformatics: Bioengineering Perspectives" to "BME 6762 Bioinformatics: Bioomedical Engineering Perspectives".

These changes are driven by the research expertise and activities of our faculty in Biosensing, Biomaterials, Neuroengineering, Medical Image Analysis, and Smart Health. Attached please find two documents for the program changes. Please let me know if you have any objections.

Your timely response to the request is greatly appreciated.

Hanqi (Hanchi)

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