

Ph.D. in Biomedical Engineering
University of Central Florida
CIP 14.0501

**Board of Governors
Staff Analysis**

June 29, 2022





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Summary

University of Central Florida (UCF) is proposing a doctorate in Biomedical Engineering. According to the U.S. Department of Labor, bioengineers and biomedical engineers apply engineering knowledge and principles to design, develop, and evaluate products such as artificial organs, prosthetics, medical information systems, and care delivery systems.¹ The proposed doctorate program will build on an existing biomedical engineering minor, faculty research, and existing partnerships and collaborations with the UCF College of Medicine, Siemens, Lockheed Martin, and the Center for Advanced Turbine Education and Research. The proposed program was approved by the University of Central Florida's Board of Trustees on November 18, 2021. If approved by the Board of Governors, the proposed Ph.D. in Biomedical Engineering will be the fifth such doctorate program in the State University System.

Program Description

The proposed Ph.D. in Biomedical Engineering is designed to prepare graduates to address medical issues concerning tissues, organs, and biofluid mechanics. For example, students will apply engineering concepts to develop assistive and rehabilitative technologies, including devices to improve diagnostic testing and human mobility.

Students admitted to the program will be required to earn 72 credit hours beyond a baccalaureate degree, complete a candidacy examination, successfully defend a dissertation, and complete four zero credit hour seminars. The specific credit hour requirements include 21 hours of biomedical engineering and statistics core courses, 36 credit hours of elective engineering and statistic courses, and 15 dissertation hours. The institution will use Education and General funding to support the program and intends to charge \$369.65 per credit hour for resident students and \$1,194.05 per credit hour for non-resident students.

If approved by the Board of Governors, UCF will implement the program in fall 2022. The proposed program will be the fifth program in the System in CIP 14.0501 and will be a Program of Strategic Emphasis in STEM.

Need for Graduates in the Labor Market

Bioengineering graduates trained at the doctoral level are prepared for employment in the biomedical industry and academia. Specifically, they may be hired as bioengineers, biomedical engineers, engineering managers, and research or teaching faculty. To demonstrate workforce demand for doctoral graduates in biomedical engineering, UCF provided employment data from the U.S. Bureau of Labor Statistics, the Florida Department of Economic Opportunity, and BioFlorida, Inc. Additionally, UCF provided sample job postings and letters of support from industry partners, which provided additional details of specific employment opportunities.

¹ <https://www.bls.gov/ooh/architecture-and-engineering/biomedical-engineers.htm>

National and Florida Workforce Demand

There is growing demand both in Florida and in the United States for graduates in the bioengineering field. Table 1 provides an overview of national and state employment demand data for potential occupations for bioengineering graduates, including anticipated openings and job-growth rates. The Florida Department of Economic Opportunity projects that Florida's demand for bioengineers and biomedical engineers will increase by 13% over the next eight years. This growth exceeds the average growth for other occupations. Nationally, the U.S. Department of Labor projects the demand for bioengineers and biomedical engineers will increase by 5.9% over the next ten years. While the entry-level education for occupations in this area may typically be a bachelor's degree, the U.S. Department of Labor estimates that 7% of bioengineering and biomedical engineering jobs require a doctoral degree.² Applying this 7% calculation to the Florida job openings for bioengineers and biomedical engineers indicates that approximately seven openings per year exist in Florida and another 90 openings nationwide that could require or prefer a doctoral-level degree.

Table 1: Labor Market Demand, CIP Code 14.0501

Occupations	Percent Change in Job Openings		Annual Average Job Openings		Total # of New Jobs		Education Level Needed for Entry
	FL 2021-29	U.S. 2020-30	FL 2021-29	U.S. 2020-30	FL 2021-29	U.S. 2020-30	
Bioengineers & Biomedical Engineers	13	5.9	106	1,400	169	1,100	Bachelor's
Engineering Teachers, Postsecondary	NOT AVAILABLE	12.5	NOT AVAILABLE	5,100	NOT AVAILABLE	5,800	Doctoral or Professional
Architectural & Engineering Managers	14.8	4.1	643	14,700	1,150	8,100	Bachelor's
Engineers, All Other	10.1	2.7	765	11,000	1,037	4,400	Bachelor's

Sources:

Date Retrieved: 2/22/2022

U.S. Bureau of Labor Statistics - <https://data.bls.gov/projections/occupationProj>

Florida Department of Economic Opportunity - <http://www.floridajobs.org/labor-market-information/data-center/statistical-programs/employment-projections>

Graduates with a doctoral degree in bioengineering may pursue positions in academia, listed as postsecondary engineering teaching in Table 1. The U.S. Department of Labor projects a 12.5% job growth nationally for postsecondary engineering teachers over the

² <https://www.onetonline.org/link/summary/17-2031.00>

next ten years. Comparable job-growth data for postsecondary engineering teachers in Florida is not available.

The University of Central Florida also provided data from BioFlorida, Inc. to demonstrate the growth of the industry in Florida. BioFlorida, Inc. is a statewide association of approximately 6,700 organizations in biopharma, medical technology, digital health, and other health-related areas. These organizations employ nearly 94,000 Floridians. According to BioFlorida, Inc.'s November 2019 Industry Report, the number of companies in Florida's biotechnology industry grew 8.5% between 2018 and the first half of 2019, bringing the total number of companies to 372.³ The report also stated that approximately 75% of Florida's biotech companies are involved in therapeutics, medical devices, or diagnostics. Students graduating from the proposed Ph.D. in Biomedical Engineering will be well-positioned for jobs in Florida's biotech companies.

Supplemental Workforce Data

Other sources of workforce demand data, which provide a closer look at the types of jobs in the industry and preferred qualifications, are sample job postings and letters of support from the industry. The University of Central Florida provided sample job postings for research and development project engineers, biomechanical engineers, and postdoctoral scientists. All of the postings listed a doctoral degree as a preferred or required qualification. For example, UCF provided a posting from J.S. Held, a global consulting firm in Orlando, seeking a biomechanical engineer who would be responsible for evaluating the mechanics of injury occurrence based on environmental conditions. Another example provided was an advertisement from the U.S. Department of Defense for a biomedical engineer in Panama City who would be responsible for designing equipment and devices such as artificial organs, replacement body parts, and machines for diagnosing medical problems.

Board staff also conducted an independent search on Indeed.com for state and national positions requiring or listing a Ph.D. as a preferred qualification. As of March 29, 2022, 58 jobs were listed in Florida, and 87 were listed nationally. The job postings included positions in public and private organizations and postsecondary education positions. For example, Advent Health advertised a senior scientist position responsible for leading the development and conducting translational research, which connects research studies to applied solutions.⁴ The sample postings provided by the institution and the independent search conducted by Board staff reinforce the workforce need for biomedical engineering graduates trained at the doctoral level.

Additionally, UCF provided letters of support from industry partners. A former graduate of UCF and the current President of Limbitless Solutions, a nonprofit organization that produces bionic limbs for children, adults, veterans, and first responders, highlighted the organization's ongoing research collaborations with UCF and hospital partners nationwide. The Co-Director of the Heart Center at Orlando Health/Arnold Palmer

³ BioFlorida November 2019 Industry Report
https://cdn.ymaws.com/www.bioflorida.com/resource/resmgr/industry_data/BioDatabase_Industry_Report_.pdf

⁴ Indeed.com "Biomedical Research PhD"
<https://www.indeed.com/jobs?q=Biomedical%20%20research%20PhD&l=Florida&vjk=a9773985c2292c49>

Hospital for Children provided a letter of support, noting the positive impact of research collaborations with current biomedical engineering faculty at UCF and the need for more graduates with advanced training in biomedical engineering. The letters also highlighted existing partnerships with local and national healthcare facilities along with the growing need for highly trained professionals in the biomedical industry to produce new treatments and innovative approaches to medical care.

Student Demand and Projected Enrollment

The proposed program will build on an existing graduate-level biomedical engineering minor at UCF. To assess students' interest in a biomedical engineering doctoral program, UCF conducted three student surveys during summer 2017, spring 2019, and spring 2021 in the mechanical and aerospace engineering, biomedical sciences, and bioengineering programs. In the most recent survey, conducted in spring 2021, 18 of 31 current and prospective biomedical and mechanical engineering graduate students indicated they were interested in pursuing a Ph.D. in Biomedical Engineering. The summer 2017 and spring 2019 surveys also yielded similar positive responses.

Projected Student Enrollment

The University of Central Florida, as shown in Table 2, anticipates the program will have 11 students in year one, including five transfer students from an existing doctoral program in Aerospace Engineering. The proposed program expects to admit approximately three to five new students each year on a space-available basis. By year five, UCF expects 27 students will be enrolled. It is important to note that students admitted to the program will join the program at various levels of their academic careers and may complete the program at different times. Additional sources of students include students in the existing Master of Science in Biomedical Engineering, College of Engineering and Computer Science Biomedical Engineering minors, and both undergraduate and graduate students engaged in biomedical engineering research.

Table 2: Projected Student Enrollment

	Student Headcount	Student FTE
Year 1	11	8.25
Year 2	16	12.00
Year 3	18	13.50
Year 4	22	16.50
Year 5	27	20.25

Alignment with Institutional and System Strategic Priorities

The proposed Ph.D. in Biomedical Engineering directly aligns with UCF's strategic mission of becoming a top 50 metropolitan research university. The proposed program

will expand the department's research capacity, formalize existing research activities in biomedical engineering, and prepare highly trained graduates to meet the growing workforce demand. The proposed program will also expand existing research partnerships with industry partners such as Siemens, Lockheed Martin, Orlando Heath, Advent Health, and Nemours.

The proposed Ph.D. in Biomedical Engineering directly supports the Board of Governors 2025 Strategic Plan goals to strengthen the quality and reputation of academic programs in the State University System and increase the number of degrees awarded in Programs of Strategic Emphasis. By leveraging existing research collaborations with local and national industry partners and the recent hiring of new faculty, the proposed program supports the Board's goal to expand community and business workforce engagement and strengthen the quality and reputation of scholarship, research, and innovation. Lastly, implementing the proposed program will increase the number of graduates in Florida's workforce with advanced biomedical engineering training, directly supporting the Board's goal to increase the community and business workforce.

Proposed Program Costs

The proposed program will be primarily funded through Education and General funds and existing or future contracts and grants. As shown in Table 3, the institution intends to expend a total of \$330,013 in year one and will expend \$626,986 in year five.

Table 3: Projected Program Costs

Total		Percentage & Dollar Amount					Auxiliary Funds	Cost per FTE	SUS 19-20 Average Cost per FTE (CIP 14)
		Current Reallocated	New Recurring	New Non-Recurring	Contracts & Grants	Philanthropy & Endowment			
Year 1	\$330,013	39% \$130,013	0% \$0	0% \$0	61% \$200,000	0% \$0	\$0	\$15,759	\$20,638
Year 5	\$626,989	25% \$154,262	0% \$0	0% \$0	75% \$427,727	0% \$0	\$0	\$7,618	

Conclusion and Board Staff Comments

If approved, the proposed Ph.D. in Biomedical Engineering will be the fifth program in the System. The institution provided sufficient evidence to demonstrate the workforce need for individuals trained at the doctoral level and to support headcount projections. The proposed Ph.D. program will support the Board of Governors 2025 Strategic Plan by producing more graduates in Programs of Strategic Emphasis while also increasing community and business engagement and the workforce. Board staff has no concerns regarding the proposed program.

Appendix A

Assessment of the University Review Process in accordance with Board of Governors Regulation 8.011

Prior to submitting a program proposal to the Board of Governors' office, the institution and its Board of trustees are required to ensure that all programs meet the requirements of Board of Governors Regulation 8.011. Section C is an assessment of the university's review process to ensure that all criteria have been considered.

ACCOUNTABILITY

Check either the "yes" or "no" box and make comments beneath the criterion as appropriate.

1. **Overall** – *The proposal is in the correct format, includes all necessary signatures, and contains complete and accurate tables for enrollment projections, faculty effort, and the proposed budget.*

YES NO

- The proposal has been approved by the university board of trustees and includes all required signatures.**

The program proposal was approved by the UCF Board of Trustees at their November 18, 2021, meeting.

- The university has provided a proposal written in the standard State University System format, which addresses new academic program approval criteria outlined in Board of Governors Regulation 8.011.**

The University of Central Florida submitted the proposed program in the standard State University System format.

- The pre-proposal was reviewed by the Council of Academic Vice Presidents Academic Coordination Group, and any concerns identified by the group have been listed and addressed in the proposal.**

The CAVP Academic Coordination Group reviewed the pre-proposal on October 5, 2017, and no concerns were expressed.

- The university has provided data that supports the need for an additional program in the State University System as well as letters of support or concern from the provosts of other state universities with substantially similar programs.**

The University of Central Florida provided sufficient data to support the need for an additional program. Currently, five System institutions offer a doctoral program in the same CIP as the proposed program, with two of these programs offered jointly through the FAMU-FSU College of Engineering. The proposal notes three key areas that set the proposed program apart from existing programs in the System. The first area is the program's focus on preparing graduates to address medical issues concerning tissues, organs, and the body as a system. Secondly, the

program will prepare students to develop assistive surgical technology, prosthetics, and tools to improve novel diagnostics. Lastly, the program's unique placement in the Department of Mechanical and Aerospace Engineering allows students to take courses in biofluids and biomechanics, which sets it apart from other programs in the System. See page 15 of the proposal for details.

The University of Central Florida received overall positive responses from other System institutions. The University of Florida noted in a letter of support for the proposed program that there are more applicants than can be supported by the University of Florida program, demonstrating the need for an additional program in the System. See page 89 of the proposal for details. The institution also received letters of support from the University of Florida, the FAMU-FSU College of Engineering, and Florida International University.

- The university has provided complete and accurate projected enrollment, faculty effort, and budget tables that are in alignment with each other.**

The University of Central Florida submitted all required tables in Appendix A of the proposal.

- The university has included a statement in the proposal signed by the equity officer as to how this proposal will meet the goals of the university's equity accountability plan.**

The equal opportunity officer signed the proposal on June 25, 2021.

- The program does not substantially duplicate programs at FAMU or FIU or, if it does, evidence was provided that consultations have occurred with the affected university on the impact of the new program on existing programs.**

The FAMU-FSU College of Engineering and Florida International University (FIU) offer programs in the same CIP as the proposed program; however, the focus of the programs is different. The proposal states that FIU's program focuses on engineered tissue model systems, diagnostic bio-imaging, and neurotechnology. The proposal also notes that the FAMU-FSU College of Engineering program focuses on cellular and tissue engineering. See page 17 of the proposal for details. The University of Central Florida provided letters of support from both institutions. The letters highlighted UCF's unique focus on biofluids and biomechanics, the collaboration between UCF and its College of Medicine, and the positive contributions the proposed program will make in Florida, indicating there will be no impact on the enrollment in existing programs.

2. Budget – *The proposal presents a complete and realistic budget for the program consistent with university and Board of Governors policy and shows that any redirection of funding will not have an unjustified negative impact on other needed programs.*

YES NO

- The University Board of Trustees has approved the most recent budget for this proposal.**

The budget for the proposed program was approved in conjunction with the full

proposal by the UCF Board of Trustees on November 18, 2021.

- The university has reviewed the budget for the program to ensure that it is complete and reasonable, and the budget appears in alignment with expenditures by similar programs at other System institutions.**

The cost per full-time equivalent for the proposed program aligns with the 2019-2020 State University System's expenditure analysis for graduate programs in the CIP 14.

- The proposal indicates that the program will follow the cost-recovery or market-rate funding models. If so, details and timelines for getting approvals for these funding models are included in the proposal.**

The proposed program will not operate using a cost-recovery or market-rate funding model. UCF will utilize E&G funding to support the program.

- In the event that resources within the institution are redirected to support the new program, the university has identified this redirection and determined that it will not have a negative impact on undergraduate education, or the university has provided a reasonable explanation for any impact of this redirection.**

The University of Central Florida anticipates that implementation of the program will yield no negative impact on related undergraduate programs.

READINESS

Check either the "yes" or "no" box and make comments beneath the criterion as appropriate.

3. Program Quality – *The proposal provides evidence that the university planning activities have been sufficient, and responses to any recommendations to program reviews or accreditation activities in the discipline pertinent to the proposed program have been addressed.*

YES NO

- The university has followed a collaborative planning process for the proposed program in accordance with policies and procedures adopted by the university board of trustees.**

The University of Central Florida provided a narrative and chronological table of events that occurred during the development of the proposal and a list of the campus constituents involved. The table and narrative provide sufficient evidence that the institution followed a collaborative planning process according to the policies and procedures adopted by the UCF Board of Trustees.

- An external consultant has reviewed the proposal and supports the department's capability of successfully implementing this new program.**

Dr. Ted Conway, Professor of Biomedical Engineering at Florida Technical

University, Fellow of the American Association for the Advancement of Science, and Elected Member of the College of Fellows in the American Institute for Medical and Biological Engineering, reviewed the proposed program.

Dr. Conway did not make any recommendations for improving the proposed program and supported the full implementation as presented in the proposal.

- The university has found the level of progress that the department has made in implementing the recommendations from program reviews or accreditation activities in the discipline pertinent to the proposed program to be satisfactory.**

The University of Central Florida's Department of Mechanical and Aerospace Engineering offers two programs accredited through September 2027 by the Accreditation Board for Engineering and Technology: a Bachelor of Science in Mechanical Engineering and a Bachelor of Science in Aerospace Engineering. The Master of Science in Biomedical Engineering program conducted a program review in 2018-19 using external consultants, and four recommendations were made.

The external consultant's first recommendation was for the department to continue to target a high-quality, diverse pool for graduate student recruitment. In response, the department hired additional faculty and increased the recruitment efforts geared towards students from diverse backgrounds in STEM.

The external consultant's second recommendation was for the department to enrich curriculum content in biomedical engineering and assure course offering availability. The department hired additional faculty, developed additional biomedical engineering graduate courses, and modified course offerings to meet current and future student demands.

The external consultant's third recommendation was to improve student career preparation. The department hired additional faculty with diverse backgrounds and areas of emphasis in bioengineering. Not only did this increase external funding and industry partnerships, but it also expanded the research and lab opportunities for students allowing them to be trained in additional areas related to biomedical engineering.

The final recommendation was to increase student financial support. In response, the department hired additional faculty with strong research portfolios and who had the potential to bring in external funding. The department saw an increase in external funding, thus expanding opportunities for paid graduate research positions for students enrolled in the program.

- The university has analyzed the feasibility of providing all or a portion of the proposed program through distance learning.**

The proposed program will be offered primarily through traditional face-to-face delivery on the main UCF campus. Some courses will be available at remote sites at their Lake Nona campus, utilizing a distance learning system.

- If necessary, the university has made allowances for licensure and legislative approval to be obtained in a timely manner.**

There is no applicable licensure or legislative approval required for the proposed program.

4. Curriculum - *The proposal provides evidence that the university has evaluated the proposed curriculum and found that it describes an appropriate and sequenced course of study, and that the university has evaluated the appropriateness of specialized accreditation for the program.*

YES NO

- The university has reviewed the curriculum and found that the course of study presented is appropriate to meet specific learning outcomes and industry-driven competencies discussed in the proposal.**

The University of Central Florida has provided the curriculum for the proposed program. The curriculum was developed in collaboration with the existing Mechanical and Aerospace Engineering Industry Advisory Board and medical professionals from Advent Health and Orlando Health. See page 40 of the proposal for details.

- The university anticipates seeking accreditation for the proposed doctoral program or provides a reasonable explanation as to why accreditation is not being sought.**

There are no specialized accrediting bodies available for doctoral programs in biomedical engineering. Related undergraduate programs in mechanical and aerospace engineering all hold accreditation through the Accreditation Board for Engineering and Technology.

5. Faculty – *The proposal provides evidence that the university is prepared to ensure a critical mass of faculty will be available to initiate the program based on estimated enrollments and that faculty, in the aggregate, have the necessary experience and research activity to sustain a doctoral program.*

YES NO

- The university has reviewed the evidence provided and found that there is a critical mass of faculty available to initiate the program based on estimated enrollments.**

The University of Central Florida identified 12 existing faculty members participating in the proposed program, including faculty teaching core courses and elective courses.

- The university has reviewed the evidence provided and found that the faculty, in aggregate, has the necessary experience and research activity to sustain the program.**

The University of Central Florida reviewed the credentials of all faculty members participating in the program. The institution provided biographical sketches for all faculty participating in the program in Appendix E of the proposal.

- The university has reviewed the evidence provided and found the academic unit(s) associated with this new degree to be productive in teaching, research, and service.**

The University of Central Florida provided multiple examples showing that the Department of Mechanical and Aerospace Engineering faculty are productive in teaching, research, and service. Evidence included program enrollment and degrees awarded at the bachelor's and master's level, research awards and expenditures, publications, and national and local board membership activity.

- If appropriate, the university has committed to hiring additional faculty in later years, based on estimated enrollments.**

The University of Central Florida will not hire additional faculty through year five of the proposed program.

6. Resources – *The proposal provides evidence that the university has ensured the available library volumes and serials; classroom, teaching laboratory, research laboratory, office space, equipment, clinical and internship sites, fellowships, scholarships, and graduate assistantships will be sufficient to initiate the program, and that, if applicable, funding has been secured to make more resources available as students proceed through the program.*

YES NO

- The university has provided a signed statement from the library director verifying that the library volumes and serials available are sufficient to initiate the program.**

The library director signed the proposal on July 28, 2021.

- The university has ensured that the physical space necessary for the proposed program, including classrooms, laboratories, and office space, is sufficient to initiate the program.**

The University of Central Florida provided descriptions of the physical spaces available to the program, including research, teaching, and office spaces that support the implementation of the program. The proposal indicates that no additional space is needed to implement or sustain the proposed program through year five.

- The university has ensured that the necessary equipment is available to initiate the program.**

The University of Central Florida provided an exhaustive list of equipment available to support the instruction and research of the proposed program.

- The university has ensured that fellowships, scholarships, and graduate assistantships are sufficient to initiate the program.**

The University of Central Florida indicated that students would receive graduate assistantships totaling \$200,000 in year one, increasing to \$472,727 in year five.

- If applicable, the university has ensured that the department has arranged a suitable number of clinical and internship sites.**

Internships are not required for the proposed program. Still, opportunities for internships and practicum experiences are available through the UCF College of Medicine, Burnett School of Biomedical Sciences, the Orlando Veterans Affairs Medical Center and Veterans Affairs Hospital, Nemours Hospital, and various hospitals as a part of the Orlando Health and Florida Hospital Health Systems partnerships, as well as additional clinical opportunities through the Lake Nona Medical Center. See page 68 of the proposal for details.



STATE UNIVERSITY SYSTEM OF FLORIDA





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