

Ph.D. Materials Science  
and Engineering  
Florida Agricultural and  
Mechanical University  
CIP 40.1001

**Board of Governors**

**Staff Analysis**

November 10, 2022







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## Summary

Florida Agricultural and Mechanical University (FAMU) proposes a doctorate in Material Sciences and Engineering as a joint degree offering with the current program at Florida State University (FSU) in the FAMU-FSU College of Engineering. The proposed program will prepare graduates to apply knowledge gained from understanding, developing, testing, and applying materials to form the foundation for present and future technologies. This program will utilize faculty currently teaching in other related programs in FAMU-FSU College of Engineering, FAMU's physics and chemistry departments, and FSU's existing materials science and engineering program. According to the U.S. Department of Labor, material scientists study various materials' structures and chemical properties to develop new products or enhance existing ones. Similarly, materials engineers determine ways to strengthen, combine and create new materials. They then apply the study of materials to solve problems in various engineering fields, such as mechanical, chemical, electrical, civil, nuclear, and aerospace.<sup>1</sup> Doctoral program graduates could enter the Florida labor market in federal research laboratories in the panhandle region, including Eglin and Tyndall Air Force Bases, the Naval Surface Warfare Center, and the Naval Air Station in Pensacola. The Florida Agricultural and Mechanical University Board of Trustees approved the proposed program on June 2, 2022. If approved by the Board of Governors, the proposed Ph.D. in Materials Science and Engineering will be the second program in the State University System in CIP 40.1001. Three other similar programs in the System are in CIP 14.1801.<sup>2</sup>

## Program Description

The Materials Science and Engineering doctoral program will allow students to gain a specialty in magnetic materials, materials for 3-D printing, nano biomaterials, multifunctional polymers, sensors for structural materials, catalysts, and electrolytes for batteries. Graduates can apply their understanding of advanced materials to create and solve problems with new technology, such as batteries that power electronic devices and electric vehicles, solar cells for green energy, and advanced composites in the latest generation of commercial aircraft.

Prospective students applying to this doctoral program must have either an undergraduate or graduate degree in a STEM-related field. Students admitted with a bachelor's or master's will be required to complete 54 credit hours, of which a minimum of 27 credits must be letter graded, and a minimum of 24 credits must be in doctoral-level research. Students must complete a written qualifying exam, a preliminary exam, and successfully defend a dissertation. The specific credit hour requirements include 12 credit hours of fundamental material sciences core courses, one elective core course on either synthesis and processing or characterization of materials, and five credit hours of elective specialization courses, including chemistry of materials, energy systems, and

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<sup>1</sup> U.S. Department of Labor Materials Engineer Profile. Retrieved on 9/28/22 from: <https://www.bls.gov/ooh/architecture-and-engineering/materials-engineers.htm#tab-1>

<sup>2</sup> CIP Code 40.1001 classify materials science programs with a foundation of the physical sciences. CIP Code 14.1801 classify programs in materials engineering with a foundation of engineering principles.

condensed matter physics. Graduates will have completed 24 credit hours for dissertation research and a seminar series with visiting scientists and faculty presenting information on advances in materials research.

If approved by the Board of Governors, FAMU will implement the program in fall 2023 at the currently approved graduate tuition rate of \$405.67 per credit hour for resident students and \$1,022.04 per credit hour for non-resident students.

### **Need for Graduates in the Labor Market**

Florida Agricultural and Mechanical University's proposed program will prepare graduates for employment in high-technology industries, including manufacturing, automotive, aerospace, medical science, and nanotechnology, as well as careers in academia. Recent Ph.D. graduates from the FSU Materials Science and Engineering program are in leadership roles in high-tech companies such as Advanced Conductor Technology, CERN, Enovix, General Electric, Imprint-Energy, Intel, X-energy, and several national laboratories. The institution provided email correspondence with many of these companies indicating interest in hiring FAMU graduates from this program. The institution provided data from the U.S. Bureau of Labor Statistics and the Florida Department of Economic Opportunity to demonstrate workforce demand for materials science and engineering graduates.

### **National and Florida Workforce Demand**

Projections show a steady increase in demand for graduates in the materials science and engineering industry in Florida and the United States. Table 1 provides an overview of national and state employment demand data for potential occupations for graduates, including anticipated openings and job-growth rates. The Florida Department of Economic Opportunity projects that Florida's demand for architectural and engineering managers will increase by 14.8% over the next eight years. Nationally, the U.S. Bureau of Labor Statistics projects the need for materials engineers will increase by 8.4% over the next ten years. The U.S. Bureau of Labor Statistics estimates that 33% of materials engineer jobs require a doctoral degree despite the entry-level education for occupations in this area being a bachelor's degree.<sup>3</sup> Applying the 33% estimate to the job projections data, approximately 15 annual job openings in Florida and 594 annual openings nationwide could require or prefer a doctoral-level graduate in this field. Comparable job-growth data for materials scientists' positions in Florida are unavailable, but growth nationally would be about 4%.

Graduates with a doctoral degree in materials engineering may pursue positions in academia, listed as postsecondary engineering teachers in Table 1. The projected job growth for postsecondary engineering teachers is 12.5% nationally over the next ten years and 18% in Florida by 2028.

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<sup>3</sup> U.S. Bureau of Labor Statistics Materials Engineer Profile. Retrieved on 9/28/22 from: <https://www.onetonline.org/link/details/17-2131.00>

**Table 1: Labor Market Demand, CIP Code 40.1001**

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	
Architectural and Engineering Managers	14.8	4.1	643	14,700	1,150	8,100	Bachelor's degree
Materials Engineers	11.7	8.4	44	1,800	72	2,100	Bachelor's degree
Materials Scientists	NOT AVAILABLE	3.9	NOT AVAILABLE	700	NOT AVAILABLE	300	Bachelor's degree
Engineering Teachers, Postsecondary	18.0*	12.5	164*	5,100	263*	5,800	Doctoral or professional degree

An asterisk (\*) indicates that the number or percent is based on 2020-28 projections from the Florida Department of Economic Opportunity since the 2021-29 data were unavailable.

Sources:

Date Retrieved:

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>

### Supplemental Workforce Data

Florida Agricultural and Mechanical University provided a breakdown of company job postings from the U.S. Bureau of Labor Statistics that indicate a national need for specific materials science and engineering jobs. Positions such as engineering manager, project engineer, and director of engineering were among the top three most frequently listed. Additionally, the proposal provided a race and ethnicity breakdown from the U.S. Bureau of Labor Statistics that reports that 79% of those who hold a job in the materials science and engineering discipline are White, and under 10% are African American or Hispanic/Latino. The program will contribute to closing the diversity gap within the industry by increasing the number of minorities prepared for advanced entry into the profession, specifically increasing the number of African American graduates.

Florida Agricultural and Mechanical University provided job postings from national laboratories requiring or preferring a doctorate in materials science. For example, FAMU provided a job posting from Apple for a materials engineer in Boulder, Colorado. The job responsibilities include creating materials specifications based on critical quality attributes for product design and managing relationships with manufacturers to identify emerging technologies and innovation in material sustainability and circularity. Another example included a post-doctoral scholar position at the Lawrence Berkeley National Lab in the Bay Area, California, which manages five U.S. Department of Energy Office of Science National User Facilities. This role also includes optimizing structure-processing-function relationships of a broad class of ion exchange membranes and

interfaces as part of the Hydrogen and Fuel Cell Program at Lawrence Berkeley National Laboratory.

The Board of Governors' office also conducted an independent search on Indeed.com for state and national positions requiring or preferring a doctorate. The search showed 28 jobs in Florida and over 2,000 jobs nationally as of September 12, 2022. The job postings included positions in local private organizations and postsecondary education positions. For example, Space X advertised for a materials engineer position in Cape Canaveral to collaborate with other subject matter experts, solving complex material and processing challenges on current and next-generation vehicles onsite.<sup>4</sup>

The proposed program's interdisciplinary focus and application of technical solutions align with the workforce needs found in the board office analysis and will ensure graduates are competitive when navigating the labor market.

### **Student Demand and Projected Enrollment**

The proposed program will join the existing FSU doctoral program in materials science and engineering as part of the joint FAMU-FSU College of Engineering. There are 13 students enrolled in the current FSU Materials Science and Engineering doctoral program. The joint college surveyed 36 students at FAMU and other historically Black colleges and universities with undergraduate degree programs such as chemistry, physics, and engineering that could feed into the proposed program. The survey indicated that 17 students were highly interested in pursuing a graduate degree in materials science and engineering at FAMU. Nearly a third of the survey respondents, 12 out of 36, indicated they would likely apply to the proposed master's and later apply to the doctoral program if offered. Respondents also indicated they prefer a face-to-face program delivery to a hybrid or online delivery.

### **Projected Student Enrollment**

Florida Agricultural and Mechanical University, as shown in Table 2, anticipates the program will have two full-time students in year one. The program expects to grow modestly each year until it reaches at least five students by year five. The institution plans to develop marketing strategies to recruit students from undergraduate programs at FAMU, FSU, and other institutions nationwide.

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<sup>4</sup> Indeed.com “Materials Science Engineer PhD.” Retrieved on 9/12/22 from: <https://www.indeed.com>

**Table 2: Projected Student Enrollment**

	<b>Student Headcount</b>	<b>Student FTE</b>
<b>Year 1</b>	2	2
<b>Year 2</b>	2	2
<b>Year 3</b>	3	3
<b>Year 4</b>	4	4
<b>Year 5</b>	5	5

### **Alignment with Institutional and System Strategic Priorities**

As part of the institution's land-grant status, FAMU's strategic mission is to enhance constituents' lives through innovative research, cooperative extension, and public service. The need for advanced knowledge in materials science and engineering is steadily rising with the increased prevalence of materials such as batteries, nanotechnology, and other building materials. Florida Agricultural and Mechanical University's Materials Science and Engineering program will equip graduates to handle complex problems by utilizing creative thinking to address real-world issues associated with the advances in materials science and engage in innovative research through classroom instruction or in research labs at the federal and state level. The program is unique in its collaboration of two universities with faculty and resources dedicated to the program, including access to major research facilities in the area that aid in the program's research outcomes.

The proposed program is consistent with the Board of Governors 2025 Strategic planning goals. By joining the existing program at FSU, the approval of this program will increase the number of degrees awarded in the Programs of Strategic Emphasis. This program supports the FAMU and State University System's mission of increasing minority doctoral candidates while educating more diverse students in high-tech STEM fields to compete in the global economy.



## 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, FAMU intends to expend a total of \$90,232 in year one and \$150,232 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 40)
		Current Reallocated	New Recurring	New Non-Recurring	Contracts & Grants	Philanthropy & Endowment			
<b>Year 1</b>	\$90,232	45% \$40,647	0% \$0	0% \$0	55% \$49,585	0% \$0	\$0	\$20,323	\$14,536
<b>Year 5</b>	\$150,232	27% \$40,647	0% \$0	0% \$0	72% \$109,585	0% \$0	\$0	\$8,129	

## Conclusion and Board Staff Comments

Florida Agriculture and Mechanical University provided sufficient evidence to demonstrate the workforce needs for individuals trained at the doctoral level and to support headcount projections. Additionally, the proposed program will support the Board of Governors 2025 Strategic Plan by producing more graduates in the Programs of Strategic Emphasis and by contributing to a more diverse workforce. Board staff has no concerns regarding the proposed program.

Check "yes" or "no" for each box in Appendix A and include comments beneath the criterion, as needed.

## 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.**

Florida Agricultural and Mechanical University Board of Trustees approved the program proposal at their June 2, 2022, 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 Florida Agriculture and Mechanical University 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 Council for Academic Vice Presidents Academic Coordination Group reviewed the pre-proposal on September 2, 2022, and did not express any concerns.

- 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.**

Input from the Council for Academic Vice Presidents Academic Coordination Group meeting suggested that local and national demand is available for materials scientists and engineers. As part of the joint college, collaborations between FAMU and FSU will occur organically. Collaborations with other institutions may also result due to the interdisciplinary nature of the program and research opportunities available to faculty. The program is unique in its collaboration of two universities with faculty and resources dedicated to the program, including access to major research facilities in the area that aid in the program's research outcomes. See page 22 of the proposal for details.

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

Florida Agricultural and Mechanical University 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 July 15, 2022.

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

Florida International University did not express any concerns.

**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 FAMU Board of Trustees approved the budget in conjunction with the full proposal on June 2, 2022.

- 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 CIP 40.

- 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. The institution will utilize Educational and General funding and Contract and Grants 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 institution anticipates that the proposed program's implementation 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 Florida Agricultural and Mechanical University provided a narrative and chronological table of events during the proposal's development 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 FAMU Board of Trustees.

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

Dr. William H. Warnes, Professor of Mechanical Engineering at Oregon State University, conducted an external review of FSU's Ph.D. in Materials Science and Engineering in 2018. The review noted various strengths and weaknesses in the materials science and engineering program at FSU. However, Dr. Warnes concluded that the program is a successful graduate program with high-quality faculty and students.

- 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.**

Florida State University has changed the existing materials science and engineering doctoral program since the external review and remains productive. Florida Agricultural and Mechanical University plan to join the current FSU program and implement an identical curriculum for FAMU graduate students.

The external reviewer provided the strengths and weaknesses of the doctoral program at FSU. Since then, FSU has made progress toward addressing the weaknesses.

The first weakness was that the materials science and engineering program did not control the core course content. A core course, Thermodynamics for Materials Science, has been created specifically as a core course for this program and is housed within the Department of Mechanical Engineering in the FAMU-FAU College of Engineering, improving more oversight.

A second weakness was no faculty appointment dedicated to the program directly. The institution explained the materials science and engineering program is interdisciplinary, involving more than one department. Therefore, it does not have a single department with direct faculty members. The program continues to have input in the individual departments' hiring process to inform prospective faculty members about the program.

The third weakness was the zero direct financial support and low administrative support, which could hinder program growth. The materials science and engineering program now has direct financial support for first-year fellowships from FSU. Additional funding will also be made available from FAMU for admitted doctoral students.

The full report is in the Appendix.

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

The courses will be delivered face-to-face at the FAMU-FSU College of Engineering, FAMU main campus, or on the FSU campus as part of the cooperative agreement between the two universities.

- 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 curriculum for the proposed program will be identical to the existing FSU Materials Science and Engineering doctoral program. Students can take courses at either institution as part of the FAMU-FSU cooperative agreement. See page 24 of the proposal for details.

The institution developed industry-driven competencies for the program based on a review of job postings for post-doctoral positions and recommendations provided by national laboratories. See page 35 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 accreditation agencies for graduate programs in materials science and engineering. The Accreditation Board for Engineering and Technology only accredits undergraduate programs.

**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.**

Florida Agricultural and Mechanical University identified nine faculty members who have been productive in teaching, research, and grant acquisition in materials science and engineering. The program will utilize faculty from other colleges, such as physics and chemistry, to support the interdisciplinary curriculum. Faculty from FSU's existing program will also continue to contribute to the program.

- 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.**

Florida Agricultural and Mechanical University reviewed the credentials of all faculty members participating in the program. The institution included the curriculum vitae of all FAMU 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 institution demonstrated that FAMU faculty are productive in teaching, research, and grant acquisition. Evidence included professional publications, graduate enrollment, research activities funded, number of master's thesis and doctoral dissertations supervised, and conference presentations.

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

The institution will not hire new faculty through year five of the 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 13, 2022.

- 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 Florida Agricultural and Mechanical University indicated that each faculty member has research laboratories with specialized research equipment to carry out high-quality research. Faculty members and students will access appropriate lab space and shared facilities in the National High Magnetic Field Laboratory (MAGLab) and the High-Performance Materials Institute in Innovation Park. Due to the remodeling of the Centennial Research Building for a new faculty member doing materials-related research, more space will be available to students. All these facilities are adjacent to the FAMU-FSU College of Engineering. Additionally, the institution stated the chemistry and physics departments have ample space within the classrooms and laboratories to accommodate student enrollment from the proposed program.

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

In addition to faculty having specialized equipment in their laboratories, faculty members have access to shared equipment within their department. All students in the program will have access to materials and instructional materials to support teaching and learning. Faculty members associated with the High-Performance Materials Institute and the National High Magnetic Field Laboratory have access to shared equipment in these two research facilities.

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

Florida Agricultural and Mechanical University indicated that students would receive graduate assistantships totaling \$20,000 in year one, increasing to \$40,000 in year five.

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

The proposed program does not require internships.





# STATE UNIVERSITY SYSTEM OF FLORIDA





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