

**BOARD OF GOVERNORS
STATE UNIVERSITY SYSTEM OF FLORIDA
NEW DOCTORAL DEGREE PROPOSAL STAFF ANALYSIS**

Program: Ph.D. in Applied Mathematical Sciences

CIP Code: 27.0301

Institution: Florida International University

Proposed Implementation Date: Fall 2017

Staffed By: C. Oakley

Initial Review Date: 3/20/17 **Last Update:** 4/5/17

Projected program costs:

	Total	% & \$ Current Reallocated	% & \$ New Recurring	% & \$ New Non- Recurring	% & \$ C&G	Auxiliary Funds	Cost per FTE	SUS 15-16 Average Cost per FTE
Year 1	\$104,318	61% \$63,318	0% \$0	0% \$0	39% \$41,000	\$0	\$15,830	\$12,130* CIP 27
Year 5	\$427,274	64% \$274,274	0% \$0	0% \$0	36% \$153,000	\$0	\$13,714	

* NOTE: The range of costs associated with the Average E&G Cost per FTE can vary considerably by university due to factors related to enrollment scale and diversity of programs in any particular CIP Code.

Projected FTE and Headcount are:

	Student Headcount	Student FTE
First Year	4	4
Second Year	8	8
Third Year	13	13
Fourth Year	18	18
Fifth Year	20	20

On March 29, 2007, the Florida Board of Governors approved Board Regulation 8.011, which sets forth criteria for implementation and authorization of new doctorates by the Board of Governors, as well as criteria for implementation and authorization of Bachelor's, Master's and Specialist degrees by Boards of Trustees. The following staff analysis is an assessment of how well the university meets Board Accountability and Readiness criteria for implementation of this degree program.

Proposal Page Numbers

INTRODUCTION		ACCOUNTABILITY		READINESS				
Program Description	BOG Goals	Overall	Budget	Mission and Strength	Program Quality	Curriculum	Faculty	Resources
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A. Program Description:

The Florida International University (FIU) is proposing to offer a Doctor of Philosophy in Applied Mathematical Sciences at its main campus.

The proposed Doctor of Philosophy in Applied Mathematical Sciences is offered in response to industry need for trained applied mathematicians and from undergraduate students interested in pursuing an advanced degree. The program will be offered at the Florida International University main campus in a traditional delivery format.

The discipline of Applied Mathematical Sciences greatly impacts many other disciplines, such as biology, chemistry, physics, engineering, computer sciences, economics, and finance. The need for new and sophisticated mathematical techniques to solve problems encountered by new discoveries is of prime importance.

The proposed program is intended to have a broad scope within mathematical sciences, with an emphasis on applications. The program will “train young mathematicians for careers as professional researchers and educators” (p. 3). A key feature of the program is the required Applied Experience Component, which includes a weekly series of colloquia in applied mathematical sciences, a one semester paid internship for students at an organization outside of the university, and a departmental presentation that students will make upon completion of their internship (p. 2). This required combination of course work, experience and research will enable graduates to pursue a career in either academic or non-academic settings and it will provide them with an opportunity to acquire employment skills and networking opportunities with potential employers.

To be admitted to the program, students must have a bachelor’s degree in mathematics or another quantitative field and have a GPA of at least 3.0. The program will require 75 credit hours beyond the bachelor’s degree: 23 credit hours of required core courses; 12 credit hours of required dissertation preparatory courses; 25 credit hours of independent study and seminars and dissertation research; and 15 credit hours to be chosen in consultation with the graduate committee (p. 21). The program will also require students to complete a one semester paid internship at an agency outside of the university.

B. System-Level Analysis and Evaluation in accordance with BOG Regulation 8.011:

The proposal states that the Ph.D. in Applied Mathematical Sciences adheres to the goals for Excellence, Productivity, and Strategic Priorities in the *SUS Strategic Plan for 2012-2025*. The proposed program will support the BOG strategic plan goal of increasing the number of STEM degrees awarded and aligns with the BOG strategic plan goal of improving the quality of teaching by using Ph.D. students to teach service and upper division courses (p. 4). With the addition of Ph.D. graduate students, recitation sessions for courses required in STEM programs,

such as Calculus I, II, and III, will be offered for the first time and should result in increased graduation rates for students in associated STEM disciplines (p. 4).

Need For Graduates in the Labor Market

With regard to need and demand, the proposal states that graduates of the program will be prepared for careers in academia and industry. Employment projections included in the proposal show that there is an increasing demand by major companies and governmental agencies for highly skilled mathematical scientists, and it cites multiple sources to substantiate this.

A search on 3/28/17 by Board staff of the *Chronicle of Higher Education*, the U.S. Department of Labor, and Indeed.com finds that there is a projected increase for jobs in mathematics. As provided in the proposal and documented by Board staff, employment of mathematicians nationally is projected to grow 21% from 2014 to 2024, which is must faster than the average for all occupations. In 2014 in the U.S., mathematicians held 3,500 jobs with 30% working for the federal government, 16% conducting scientific research and development services, 13% working in academia, 7% employed in finance and insurance, and 5% working in manufacturing. It is important to note that these national employment projections do not separate applied mathematics from general mathematics. (Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition, Mathematicians*, on the Internet at <https://www.bls.gov/ooh/math/mathematicians.htm>, visited March 27, 2017).

Table 1 below shows open positions as of 4/24/17 found by Board staff.

Table 1: Job Openings in Mathematics and Applied Mathematics

Job Ads	Number of Positions		Minimum Educational Level Required	Type of Job	Source
	Florida	Nationwide			
Mathematics	68	115	bachelor's w experience, and/or master's	faculty, software development, data scientist	jobs.siam.org, Higherjobs.com
Applied Mathematics	38	64	bachelor's w experience, and/or master's	faculty, software development, data scientist	Higherjobs.com
Mathematics Professor	17	143	bachelors, masters at cc/state colleges, Ph.D. universities	adjunct/fulltime faculty, administrative, professional	Chronicle.com, Higherjobs.com
Applied Mathematics Professor	15	113	bachelors, masters at cc/state colleges, Ph.D. universities	adjunct/fulltime faculty, administrative, professional	Chronicle.com, Higherjobs.com

Table one provides a snapshot of job openings (may include some duplicate postings) for graduates in mathematics and applied mathematics in industry and academia. Available jobs

range from entry level to professional and require a bachelor's degree, master's and/or doctoral degree depending upon the level of position and type of organization.

The proposal states that in 2012-2013 there were 1,843 new Ph.D. graduates in mathematical sciences. Board staff found that more recent data show that in 2014-2015 there were 1,901 Ph.D.s in mathematical sciences awarded, which is an increase from 2012-2013. However, the number of Ph.D.s awarded in "applied" mathematics decreased 14% in 2014-2015 compared to 2013-2014, and 12% (221 of 1,901) of Ph.D. students had dissertation topics in applied mathematics (Report on the 2014-2015 New Doctoral Recipients (2016), *American Mathematical Society*, Vol. 63, No. 7).

The proposal cites an American Mathematical Society report that found that Black and Hispanic students are underrepresented in mathematical sciences as 25 (0.01%) graduates out of 1,843 Ph.D. graduates in 2012-2013 were Hispanic and 24 (0.01%) were African American (<http://www.ams.org/profession/data/annual-survey/2013Survey-NewDoctorates-Supp-TableD2.pdf>).

According to the consultant's report, the proposed program will help improve minority student representation. Because of Florida International University's location and demographics, it is ideal to recruit much-needed minority enrollments and increase degrees awarded in applied mathematical sciences. Board staff found that in 2014-2015 there were 70 (0.03%) Hispanic students and 39 (0.02%) African American students who earned a Ph.D. in mathematics, which represents an increase in graduate degrees awarded for Hispanic and African American students in 2014-2015 compared to 2012-2013 (Report on the 2014-2015 New Doctoral Recipients (2016), *American Mathematical Society*, Vol. 63, No. 7).

Student Demand for the Program

To assess demand for the proposed program, the university conducted a survey of its undergraduate math majors. Results of the survey showed that 23 of the 28 respondents (82%) intended to pursue a Ph.D. program in mathematical sciences. In answering the survey question "In case FIU were to offer a Ph.D. program and you applied for it, would FIU be among your top 5 choices?", 25 of 28 (89%) respondents answered yes. In answering the survey question "If FIU offered you admission into its Ph.D. program, would you seriously consider entering the program?" 26 (93%) respondents answered yes.

Additionally, the proposal cites a report that found that approximately 50% of undergraduate students majoring in mathematical sciences pursue a graduate program (<http://cew.georgetown.edu/whatsitworth/>). This is one of the highest percentages among all sciences, and there is an average 33% earnings boost from obtaining a graduate degree in mathematics and a 56% earnings boost from obtaining a graduate degree for applied math majors (<http://cew.georgetown.edu/whatsitworth/>).

Board staff reviewed the "What's It Worth" report and found that in fact 52% of undergraduate applied mathematics undergraduate students obtained a graduate degree. However, the report does not distinguish between a master's and Ph.D. level programs (<http://cew.georgetown.edu/whatsitworth/>).

Board staff also reviewed the BOG Interactive University Database for degrees awarded in the SUS for bachelor's and master's students, in applied mathematics and mathematics, general, who may be interested in pursuing a Ph.D. in Applied Mathematical Sciences. In the SUS there were 325 baccalaureate degrees awarded in 2013-2014, 330 in 2014-2015, and 336 baccalaureate degrees awarded in 2015-2016. There were 90 master's degrees awarded in mathematics, general in 2013-2014, 110 awarded in 2014-2015, and 90 in 2015-2016. Additionally, there were 37 master's degrees in applied mathematics awarded in 2013-2014, 20 awarded in 2014-2015, and 37 in 2015-2016 (BOG Interactive University Database, accessed 3/29/17).

Assistantships

The proposal notes that four (4) students (p. 10) will be provided stipends (\$9,500 per student) for graduate teaching assistantships in year one for a total of \$38,000 (Appendix A, Table 2). By year five 20 students will be provided stipends (p. 10) for a total of \$133,000 (Appendix A, Table 2). Therefore, providing assistantships for all of the students projected to enroll in the program will likely help recruit students for the program.

External Consultant's Report

Dr. Emil Straube, a professor and department head in the Department of Mathematics at Texas A & M University, served as the external consultant for the proposed program. In his report, Dr. Straube states that he fully supports the program, and notes that the "proposal is very well thought out, formulated, and documented in all aspects." Further, Dr. Straube notes that, because of its location, Florida International University is in an ideal position to become the leading university to graduate Hispanic Ph.D. students in mathematics (p. D-5).

Dr. Straube made several recommendations which are addressed in the proposal, including establishing an advisory panel with industry representation and incorporating life sciences as elective course options in the curriculum, which are addressed the proposal.

Analyst Summary

The proposed Ph.D. in Applied Mathematical Sciences aligns with the SUS Strategic Plan for 2012-2025 goals of Excellence, Productivity, and Strategic Priorities, and it will support the BOG strategic plan goal of increasing the number of STEM degrees awarded.

Based upon open positions found by the BOG staff, many mathematician jobs require a master's degree, with the exception of tenure-track faculty and top administrative positions in universities, which require a Ph.D. This could potentially result in some of the graduates of the proposed program being over-qualified for some industry positions.

C. Assessment of the University Review Process in accordance with BOG Regulation 8.011:

Due to the system of stair step accountability set in place by the Board of Governors in Regulation 8.011, it is now incumbent upon University Board of Trustees to verify that all doctoral programs coming before the Board of Governors have met the requirements of the regulation. The following is an assessment of the university review process to ensure that all criteria set forth have been considered by the university prior to submission to the Board of Governors office.

ACCOUNTABILITY

Check 'yes' or 'no' box, and make comments beneath 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 proposal was presented to the University's Board of Trustees on 12/1/16.

 The university has provided a proposal written in the standard SUS format which addresses new academic program approval criteria outlined in BOG Regulation 8.011.

The academic program proposal was written in the standard SUS format and in accordance with the criteria set forth in Board Regulation 8.011.

 The pre-proposal was reviewed by the Council of Academic Vice Presidents (CAVP) workgroup and any concerns identified by the group have been listed and addressed in the proposal.

The proposal was presented to the Council of Academic Vice Presidents workgroup on September 28, 2016 and no concerns were identified.

 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 proposal contains data related to employment needs for graduates in applied mathematics, and examples of communications with students to gauge interest among students in pursuing a Ph.D. The university also provided a letter of support from the University of Central Florida, which has the only other existing Ph.D. program in applied mathematics in the SUS. The proposed program curriculum was compared to the curricula of the other 4 Ph.D. mathematics programs in the SUS with CIP 27.0101. The primary difference between the

proposed program and the others is that it has an emphasis on application and requires students to complete a one semester internship working in the field. None of the other programs require an internship, although UF does require students to teach at the college level for two semesters. Additionally, the other programs require between 80-90 hours to complete the degree, and the proposed program requires 75 hours. (Note that FSU does not provide total number of hours required for the degree on its website.)

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

The tables provided in the proposal are complete, accurate, and in alignment with each other; however, the narrative provided in the proposal (p. 9) does not align with Table 1.

- 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 university's equity office signed the proposal on September 15, 2016.

- 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 proposed program does not duplicate a program offered at FAMU.

2. Budget - *The proposal presents a complete and realistic budget for the program consistent with university and BOG 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 Florida International University Board of Trustees approved the budget for this proposal on 12/1/2016.

- 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 SUS institutions.**

The proposal describes that 0.21 and 1.13 faculty FTE will be associated with the

program in years 1 and 5, respectively. The projected E&G cost per FTE in year one is \$15,830 and in year five is \$13,714. The BOG analyst calculation for the average cost per FTE in CIP 27 using the 2015-16 expenditure analysis report is \$12,130.08. In other words, the program costs are in line with the average cost for a similar program across the SUS system.

- 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 program will be follow the traditional funding model.

- 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.**

Table 3 indicates that funds will be reallocated to support the program. However, the impact on students, faculty, and departments on campus is expected to be positive. The department plans to shift the current 14 graduate assistantships from the master's program to the doctoral program (pg. 10). Students in the program will be able to teach undergraduate and service courses. This will ultimately prove to be cost-effective for the program and serve to increase the quality of program delivery and will reduce the need for adjunct instructors.

READINESS

Check 'yes' or 'no' box, and make comments beneath 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.**

A chronological table detailing the collaborative planning process is outlined and described in the proposal, and the internal and external people have been identified in the table (p. 17).

- An external consultant has reviewed the proposal and supports the**

department's capability of successfully implementing this new program.

Dr. Emil Straube, a professor and department head in the Department of Mathematics at Texas A & M University, served as the external consultant for the proposed program. In his report, Dr. Straube states that he fully supports the program, and notes that the "proposal is very well thought out, formulated, and documented in all aspects." Further, Dr. Straube notes that, because of its location, Florida International University is in an ideal position to become the leading university to graduate Hispanic Ph.D. students in mathematics (p. D-5).

Dr. Straube made several recommendations which are addressed in the proposal, including establishing an advisory panel with industry representation and incorporating life sciences as elective course options in the curriculum, which are evidenced in the report.

- 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 findings related to the 2013 program review are listed in the proposal.

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

The university states in the proposal that the best delivery method for this program is a traditional method and providing a distance learning option is not feasible.

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

Not applicable.

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 program will "train young mathematicians for careers as professional

researchers and educators” (p. 3). A key feature of the program is the required Applied Experience Component, which includes a weekly series of colloquia in applied mathematical sciences, a one-semester paid internship for students at an organization outside of the university, and a departmental presentation that students will make upon completion of their internships.

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

There is no specialized, discipline-specific accreditation available.

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.**

As noted in the proposal, there are 21 faculty members from the Department of Mathematics and Statistics who will participate in the program. Currently at least 13 faculty hold dissertation advisory status.

- 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 Mathematical and Statistics Department has received over one million dollars in external grants within the last three years. Additionally, its faculty research output is comparable to benchmark universities such as Temple University, Auburn University, and Northern Illinois University (p. 27) with publications in top-ranked journals (p. 28). The department was ranked 102 among all mathematics departments in total research and development expenditures by the National Science Foundation (p. 27).

- 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.**

In addition to teaching and research, faculty serve as co-advisors and dissertation

members for Ph.D. committees, collaborate with faculty across campus on multiple projects and committees, and work on organizing conferences, etc. (p. 28).

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

Based on Table 4 in the proposal, the University does not plan to hire additional faculty.

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 program proposal on September 20, 2016 and noted that current library resources will meet the needs of the proposed program and no additional costs for the library are anticipated.

- 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 proposal notes that classrooms and offices for Ph.D. students are already available.

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

There is no equipment needed to launch the program.

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

The proposal allocates graduate assistantships in the budget section and projected costs are provided in Table 2.

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

The proposal provides a list of internship sites on pages 30-31 and indicates that additional placement sites will be sought by the Graduate Committee.