University of Central Florida  
2016-17 Academic Program Review  
Graduate Program Self-study

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<th>Program:</th>
<th>Mathematics, Ph.D.</th>
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<tr>
<td>Program Director/Coordinator Name:</td>
<td>Qiyu Sun</td>
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<td>Program Self-study Contact:</td>
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Instructions: Please respond to each of the following items, providing interpretations, self-assessment and reflection where appropriate. Please limit your responses to a maximum of 25 pages. Most reports will be around 15 pages.

SECT. 1. PROGRAM OVERVIEW

1.1 Provide the following:

a. program mission (refer to program’s institutional effectiveness (student learning outcomes) assessment plan)  
(a comprehensive statement that describes the purpose(s) of the program, including its main functions, activities, and stakeholders)

The objective of the Doctorate Program in Mathematics is to prepare students with the solid mathematical skills and creative ability needed to pursue professional careers in academia, government, and industry, and also to conduct influential research in mathematics and other STEM fields.

The doctorate program ultimately serves the needs of the stakeholders of the general mathematical community. These include state and national research centers, companies, government agencies that need research services in the fields of mathematics, as well as the universities and other research organizations that conduct mathematical research.

Students in the program are expected to have solid mathematical skills and to be capable to work on mathematics and other STEM disciplines.
b. if applicable, program goals and/or objectives other than those articulated in the program’s institutional effectiveness (student learning outcomes) assessment plan

not applicable.

1.2 Discuss how the program(s) support(s) the following:

a. UCF goals (see http://president.ucf.edu/documents/MissionVisionGoalsNov242009.pdf)

The objectives of the doctorate program in Mathematical Sciences supports the UCF goals of: Achieving international prominence in key programs of graduate study and research (Goal 2), Becoming more diverse and inclusive (Goal 4) and Be America's leading partnership university (Goal 5).

The PhD program in Mathematical Sciences strives to achieve these goals by being key graduate program in doing consequential research and providing a technologically capable diverse workforce.

b. State University System of Florida goals (see http://www.flbog.edu/pressroom/strategicplan.php)

The goals of the State University System of Florida (SUSF) includes "Florida must increase the educational attainment levels of its citizens and increase the entrepreneurial spirit of its workforce." and "to produce world class, consequential research, and to reach out and engage Florida’s communities and businesses in a meaningful and measurable way." The objectives of the master program in mathematical sciences are linked to the above SUSF goal though consequential research and workforce training on STEM and emerging technologies.

Students in the program are encouraged to do consequential research on STEM and emerging technologies with our excellent faculty.

Students in the program are trained to have the ability to derive mathematical statement and give rigorous mathematical reasoning, and to master basic skills on STEM and technologies, and to do consequential research for their professional careers in industries, academia and government agencies.

SECT. 2. PROGRAM COORDINATION AND ADMINISTRATION
2.1 Describe how the following functions are administered:

a. general program administration (e.g., Is there a program coordinator and/or program committee? What is his or her role or function?)

The Ph.D. program is administered by the Graduate Program Director and the Graduate Program Assistant in consultation with the Department Chair and the Graduate Curriculum Committee.

The Graduate Program Director supervise and coordinate the doctorate program on daily basis. The duties of the Graduate Program Director include: to advise students' course enrollments, to manage each student's program of study, to administer the comprehensive examination, to read and examine the application files of students and to admit new students, to make offers of Graduate Teaching Assistantships to qualified students, to work with the department chair and the graduate curriculum committee in resolving any problems of students in the program, and to communicate with college and university committees.

The Graduate Program Assistant will help the program director to manage students records, to schedule students seminars and thesis defences, to assist students with special courses enrollment (Independent Study, Directed Research, Thesis, etc.), to administer the comprehensive examinations, to prepare Graduate Teaching Assistants' contracts, to communicate with graduate students and College of Graduate Studies, to take minutes of all Graduate Curriculum Committee meetings.

The duties of the Graduate Curriculum Committee include: to oversee the admission of new students, to deal with new course and course revision requests, to review all program addition and/or revision, to set up departmental policies related to graduate program, and to make decisions on any issues that can be resolved at the departmental level.

b. student recruitment

Student recruitment is done by the faculty through their professional community with the assistance from the graduate coordinator. Updated information about the student admission is listed on graduate catalog of the university and the website of the department. Representatives of the program are presented in the UCF graduate fair on the campus to recruit local students every year, and in the AMS annual meeting to recruit national talents to join the program. Faculty in the department are invited to visit Florida universities specially to recruit qualified students, and they are encouraged to recruit national and international students when they are attending conferences.

c. student curricular (academic) advising and mentoring, including career mentoring
The program director serves as the academic mentor to all students in the program before they choose their own dissertation advisor as their academic mentors in course selection and program of study. The career mentoring is mainly by their dissertation advisor with the help from the program director.

The graduate coordinator meets with students every semester to provide advises on courses taken before students take dissertation hour only, and also on career preparation. Together with faculty, the program coordinator mentors students’ progress to the expected level of performance and professionalism. Students are required to attend weekly departmental colloquia and at least one of many seminars organized by the faculty in the department. They are encouraged to attend interdisciplinary seminars.

SECT. 3. PROGRAM DEMAND AND PRODUCTIVITY

3.1 If applicable, discuss the degree program’s university-approved “restricted access” status. Note the reason(s) why limiting or restricting access to the program is necessary.

Not applicable.

3.2 Examine the program admissions and enrollment data provided by the Office of Institutional Knowledge Management. Reflect on the growth or decline in demand for your program and comment on the future potential demand for the program.

The application pool is improving, although there is indication of variance (2010/11, 2013/14) on the acceptance rate. The program is expecting that the demand and enrollments will increase gradually in the near future.

The yield rate between enrolled students and accepted students decreases and the recent data on the yield rate is 2/15=13.3 % in the fall 2016. The program expects that the yield rate could be around 20% and even lower soon.

3.3 If applicable, identify other UCF programs outside your department that are supported by the program’s courses. Explain the extent of the support.

The department offer several core courses (such as MAT 5712 Scientific Computing and MAP 6385 Applied Numerical Mathematics) and restricted elective courses (such as MAP 6408 Perturbations and Asymptotic Methods, MAP 6465 Wavelets and Their Applications, MAP 6383 Mathematical Methods for Image Analysis, and several special topics courses of
strong interdisciplinary components), where students for mathematics and other departments, especially from college of engineering and computer sciences, take the same course and work together and share their expertise.

3.4 Refer to the department and program data provided by the Office of Institutional Knowledge Management and discuss the productivity of your program in terms of the following:

a. student credit hours generated (this may be difficult to disaggregate by program; respond as best you can on this indicator)

There is some variation on credit hours generated by the program (2011/12 and 2012/13). It is improving in last three academic years as more students are entering the program and taking dissertation hours. The program expects the credit hours will reach that peak level in next two or three years.

b. retention (if direct measures are not available, consider other indicators)

In the program, there are about 2.3% students on the retention plan from 2009 to 2016. All seven students were dismissed by College of graduate studies or discontinued for non-enrollment in 3 consecutive terms.

c. degrees awarded

There were 25 degrees awarded in the doctorate program in the period 2009-2016, that is about 3-4 degree awarded per year. Now there are 11 students taking disseration hours. Those students are expecting to graduate in next two to three years. The program expects to have 4-6 degrees awarded and 5-6 students passing the candidacy exams every year in the next few years.

d. time-to-degree

With the exception of 2013/14 and 2014/15, the time to degree is between 3.5 and 4.93 years. In the period from 2013 to 2015, there are two students in the program earned their degree in 9 and 10 years. One student shifted from the PhD program from physics, while the other has later graduation due to dissertation supervisor leaving. Almost all full-time students graduated within 6 years.
3.5 Reflect on the internal demand noted above as well as external market demand and discuss your ability to meet this demand now and in the future.

In the past four academic years, the program has about applications every year with 57 application in 2015 academic year. The program has about 17 new students and 3-4 graduation every academic year. This new student enrollment will increase slightly in next few year to around 20. The program expects to have 4–6 graduation per year in the near future.

SECT. 4. COMPARATIVE ADVANTAGE

4.1 List the aspects of the curriculum that make the program distinctive.

Our program emphasizes analysis-based applied mathematics, due to faculty expertise in the department. The program expose students to various tools in mathematical analysis including modern harmonic and functional analysis, and ordinary and partial differential equations to apply them successfully in solving inverse problems and mathematical image analysis, mathematical finance, fluid dynamics and linear and nonlinear waves. The list of applications is expanding to include: discrete mathematics, mathematical statistics, mathematical biology, big data, computer vision and signal processing.

4.2 List competing program(s), particularly those within the State University System of Florida.

There are competing PhD programs in Mathematics or Mathematical Sciences at the following State University of Florida institutions: Florida State University, University of Florida, University of South Florida, Florida Atlantic University, Florida Institute of technology. In addition the University of Miami offers a competing program.

SECT. 5. PROGRAM QUALITY

5.1 If the program is in a discipline where accreditation (or certification) is available, please identify the official name of the accrediting entity. Note whether or not the program has sought accreditation and the program’s current accreditation status.

Not applicable.
5.2 If applicable, discuss program accreditation results and the primary conclusions, recommendations, and follow-up required.

Not applicable

5.3 If applicable, provide the program’s criteria for admission.

Students entering the graduate program with regular status are required to have a working knowledge of undergraduate calculus, differential equations, linear algebra (or matrix theory), boundary value problems, statistics, computer programming, and maturity in the language of advanced calculus (at the level of MAA 4226). Students who are not adequately prepared in one or more of these areas can select appropriate courses from the undergraduate curriculum to make up such deficiencies.

5.4 If applicable, describe the national reputation or recognition of the program and list the sources of the reputation or ranking indices.

The National Research Council conducted a ranking of Research Doctoral Programs in 2010. Because of its CIP code the Ph.D. program in Mathematics was evaluated as an Applied Mathematics program. Each program was evaluated by giving a range in which the program had a high probability of placing in five different rankings. There were 34 Applied Mathematics programs.

An S-Rank based on evaluating criteria that scholars found important where UCF ranked 28-31. A research ranking bases in publications, citations, grants and awards where UCF ranked 25-29. A students ranking basis based on student completion, financial aid, etc. where UCF ranked 7-25. A diversity ranking where UCF ranked 18-26. And a B-rank where programs are compared to "top-notch" institutions where UCF ranked 26-33.

Some of the reasons for the relatively low ranking of UCF come from the character of the programs in the study. The departments in this category are predominantly small "second" mathematics institutions that are either entirely or almost entirely directed to graduate programs.

A comparison with the classification of mathematics programs, would indicated that the program was evaluated as a mathematics program the ranking would have been in the 70’s out of approximately 127 programs.

The website math-colleges.com indicates that UCF is the Best Applied & Computational School in Florida and the 34th Applied and Computational School in the US.
5.5 If applicable, provide licensure pass rates for 2013-14 through 2015-16. Include the total number of students attempting the exam and the total number who pass.

Not applicable

5.6 Does the unit or program currently collect any of the following information regarding program graduates? If so, please provide recent data in that regard.

- job placement rates and employer information
- employer satisfaction
- graduate school placement and caliber of graduate schools

A concerted effort has been made to track our doctoral graduates at least through their first job. This indicates that our graduates in the period being examined work in a variety of positions in academia, industry, and government.

In the era under consideration 2009/2016 students were employed by BB&T, Wells Fargo, MobileDevHQ, CJM Wealth Management, Epic, The Department of Defense, Lockheed Martin, Johann Radon Institute for Computational and Applied Mathematics (RICAM), Austrian Academy of Sciences, Oxford Centre for Industrial and Applied Mathematics, Mathematical Institute, University of Oxford, Ohio University, Fayetteville State University, Florida Keys Community College, and Valencia College among others.

Very small numbers of our doctoral graduates are not employed. Most graduates find employment at or before graduation. The unemployment that occurs is principally due to geographic constraints and due to personal or family reasons.

Due to the large number of employers, and the wide variety of jobs, a systematic examination of employer satisfaction has not been undertaken.

5.7 Describe curriculum changes and other curricular accommodations made in the last three years, particularly those intending to improve program quality and to respond to employer needs.

The principle change in the curriculum over the past three years in the administration of the candidacy examination. In order to encourage students to make progress throughout the candidacy examination, students can take the exam in two parts offered either in the same semester or in different semesters.
5.8 Refer to the program’s institutional effectiveness (student learning outcomes) assessment results and plans and reflect on each of the following:

a. extent to which students are achieving planned outcomes

The institutional effectiveness assessment program indicates that the student learning outcomes are being realized.

b. how the institutional effectiveness assessment process has resulted in program improvements over the last three years

Although the program institutional effectiveness has given insight into the realization of student learning outcomes that has not translated into program improvements over the previous three years.

5.9 Reflect on student perceptions of program quality based on appropriate data sources (e.g., institutional effectiveness assessment results, Graduating Senior Survey results, alumni survey data).

Graduating students have indicated a high level of satisfaction with the program.

5.10 Reflect on any curricular challenges affecting the program (e.g. course sequencing; bottlenecks; points of departure).

The most significant curricular challenge is the lack of ability to offer a broad variety of more advanced classes for doctoral students beyond the current second/third year offerings.

SECT. 6. STUDENT CHARACTERISTICS AND QUALITY

6.1 Refer to the university data provided by the Office of Institutional Knowledge Management. Comment on and discuss the program’s student characteristics over time in the following categories, as appropriate. If applicable, comment on any significant changes in the characteristics during the review period or areas in need of improvement.
a. incoming GPAs and test scores (e.g., GRE, GMAT) of applicants as well as admitted and enrolled students

There has been little change in the Average GRE score of either the applicants, or admitted students or enrolled students over the period under consideration except for the 2015/2016 pool where there was a noticeable increase in the GRE of all three categories. The Average college GPA has seen greater variation, but the values for the admitted and enrolled students tend follow the values for the applicant pool. After a particularly low pool in 2013/2014, there has been a steady increase in GPA both of the pool that is reflected in the values for the admitted and enrolled students.

b. mix of full-time and part-time students

In the program, there are about 5% of students are of part-time. Most of students are full-time students with graduate teaching assistantship or graduate research assistantship. Few of international students are supported by government scholarship.

c. mix of gender and ethnicity among students enrolled in the program

In the program, there are 35.42% (17/48) female students in Fall 2012, and 29.63% (16/54) female in Fall 2015. The number of female students in the program is almost at the same level, even the size of the program has been increased about 10% in last four years.

In the program, there are 2.08% Asian, 10.42% Hispanic/Latino, 54.17% white and 33.33% non-resident alien in Fall 2012; and 7.41% Asian, 1.85% Black/African American, 3.70% Hispanic/Latino, 1.85% Multi-racial, 44.44% White and 40.74% non-resident alien. The ethnicity of the program has been more diversified in the six years.

6.2 Discuss the general quality of the program’s applicant pool (if applicable) and enrolled majors over the review period.

Most applicants are close or beyond our minimum requirements for admission and the Ph.D. program chooses the strongest applicants. In the past, the international students were among the stronger population among the applicants but there are always several outstanding domestic applicants. Most of international students are from Asia but we also see applications from Europe, Cuba and Africa. Among domestic applications, there are on average three applications from UCF, and another 3 to 5 from other Universities in Florida. At the moment, we do not see any patterns in application pools, but the number of applications is expected to be at the same level, around 35 in next few years.
There is some sense that even beyond the numbers (GPA, GRE), both the applicant pool and the pool of enrolled majors are improving.

6.3 If applicable and known, describe the reasons why students decline admission to the program and/or assistantships and fellowships.

Reasons for students to decline admission are not collected. Some incomplete information indicates that almost all of them are enrolled in graduate programs in other universities, due to various reasons such as research interest and funding opportunity.

6.4 Provide a brief summary of student accomplishments during the review period in the following areas:

a. awards at the national, regional, state, university and college levels

One of students won a University wide teaching award for graduate teaching assistants.

b. significant scholarly and creative works and activities completed outside of regular classroom or thesis/dissertation activity (e.g., publications, presentations, performances) - include the nature of the activity and the venue and note whether the activities were refereed or juried

Incomplete data collected indicates that more than 13 students in recent years published more than 12 papers in journals, such as Journal of Number Theory, Journal of Mathematical Physics, and IEEE Signal Processing Letters. Students are invited to give several invited talks in national conferences, such as 15th International Conference on Approximation Theory, 2016 AMS Spring Central Sectional meeting in North Dakota State University. The following are some samples of students' (indicated by *) publications in refereed journals during 2014 and 2016.


c. other noteworthy student accomplishments

SECT. 7. CURRICULUM AND COURSE OFFERINGS

7.1 Describe any interdisciplinary and/or international aspects of the program.

Some of core courses and selective courses have the interdisciplinary parts and students in the other colleges took those courses. The program admits international students. Currently there are 33 international students out of 66 active students in the program.

In addition, many special topics courses of strong interdisciplinary components have been offered (such as Mathematical Image Analysis, Sparse Representation, Mathematical Biology, etc.) where students from mathematics and other department are taking the same course and work together and share their expertise.
7.2 Identify all required (e.g., core) courses for the program and describe the typical rotation in which each is offered (e.g., one section every fall term), noting any point during the past three years (2013-14 – 2015-16) when the standard rotation was not followed and why.

The six core courses of the program are MAS5145 Advanced Linear Algebra and Matrix Theory (3 credit hours); MAA 5228 Analysis I (3 credit hours); MAT 5712 Scientific Computing (3 credit hours); MAA6229 Analysis II (3 Credit hours); MAP 6385 Applied Numerical Mathematics (3 credit hours); and MAA 6405 Complex Variables (3 credit hours) or MAP 5336 Ordinary Differential Equations and Applications (3 credit hours). The first three courses are offered every fall semester and the next three courses are offered every spring semester in the past three years.

The restricted selective courses of the program includes sequences on Applied Mathematics Sequence (MAP 6407 Integral Equations and the Calculus of Variations (3 credit hours) / MAP 6408 Perturbations and Asymptotic Methods (3 credit hours)); Complex Analysis Sequence (MAA 6405 Complex Variables (3 credit hours) / MAA 6404 Complex Analysis (3 credit hours); Graph Theory Sequence (MAD 5205 Graph Theory I (3 credit hours) / MAD 6309 Graph Theory II (3 credit hours); Differential Equation Sequence(MAP 5336 Ordinary Differential Equations with Applications (3 credit hours) / MAP 6356 Partial Differential Equations (3 credit hours); Probability and Statistics sequences(MAA 6238 Measure and Probability I (3 credit hours) / MAP 6111 Mathematical Statistics (3 credit hours); and Analysis Sequences (MAA 6306 Real Analysis (3 credit hours) / MAA 6506 Functional Analysis (3 credit hours). Each sequence list above are offered mostly once every two years.

7.3 List any instructional sites (including regional campus or other sites) off the Orlando campus where any portion of the program is available via face-to-face instruction (e.g., P or M modes). (Please note that Research Park is considered part of the Orlando campus.)

All fact-to-face instruction are conducted in the Orlando main campus.

7.4 Describe the program’s distance learning (e.g., W, V, RV) offerings, including the proportion of the program available via distance learning modality.

Two of core courses of the program ( MAS5145 Advanced Linear Algebra and Matrix Theory (3 credit hours); MAT 5712 Scientific Computing (3 credit hours)) are available via distance learning modality. This distance learning helps the first year students gradually to
adapt to the program, and students have more time to learn mathematical skills for the online preparation.

SECT. 8. STUDENT ENGAGEMENT

8.1 Describe any research and creative opportunities for students in the program (e.g., master’s thesis track) and indicate if they are required or optional. If optional, discuss participation rates.

Students are encouraged to do research with our dedicated faculty. Students select an advisor for the dissertation after passing the candidacy exam. They must take at least 15 credit hours on dissertation and finish their dissertation.

8.2 Describe any student internship opportunities and indicate if they are required or optional. If optional, discuss participation rates.

An internship is not required for the doctorate program. Students are encouraged to take an internship.

8.3 Describe any other engagement activities available to students in the program (e.g., study abroad) and indicate if they are required or optional. If optional, discuss participation rates.

Students are encouraged to attend national workshops and conferences, and present their research. The program does not have exchange program with international universities for students to study abroad. The department is a member of the Institute for Mathematics and its Applications. The department will provide some travel support for students to present their research in a professional meeting when budget permits. Students has attended several workshops oraganized by national institutions on Mathematics.

SECT. 9. SWOT ANALYSIS

9.1 List program strengths.

The Faculty is the greatest strength of the Department. The Faculty includes internationally recognized researchers with a strong representation in several areas of
research. Faculty members in the department include invited speakers at the International Congress of Mathematics, the Marcus Wallenberg Prize winner, Fellows of the American Mathematical Society, and a National Science Foundation Career awardee.

9.2 List program weaknesses.

The size of the program is too small to address the needs both of the university and the department. The university goal to reach greater prominence in this graduate program faces two obstacles: first there is a need for more financial support and tuition waiver for students in the program, second there is a need to invest more seriously in recruitment to deepen both the domestic and international applicant pool.

Space is also a program weakness. There is both a qualitative and a quantitative need for space. There is a shortage of meeting spaces for both formal and informal seminar and discussion. There is also a serious need of space for student's individual research and deliberation. In addition there is a vocalized need for a departmental computational laboratory to address the numerical and symbolic need of student research.

9.3 List program barriers, threats, and unique vulnerabilities (e.g., loss of one faculty member may result in inability to offer program).

Relatively low graduate teaching assistant stipends in comparison with competing institutions is a strong limitation on recruitment. Budgetary limitations also limit the number of offers that can be made in recruitment.

The program does not face any threat in offering its core courses but several specialization areas may be vulnerable if key faculty members leave the department. Two such examples are mathematical finance and computational mathematics.

9.4 Discuss potential opportunities in the following areas:

a. actions to improve program quality

There are opportunities to increase the department's visibility in areas interdisciplinary mathematical research. There are already a small number of UCF faculty in other departments that have secondary joint appointments in the Department of Mathematics, and the department is looking for other faculty to expand the research potential of the program to active areas of interdisciplinary mathematics.
b. new ventures to increase demand or improve competitiveness (e.g., internal or external partnership opportunities)

A potential direction of development is to develop new emphasis more on modern applications of mathematics in image/information sciences, finance, biology, statistics, and industry. This would enable the department to extend our effort on industrial partnerships to the Ph.D. level.

c. actions to achieve productivity gains (e.g., recruitment, non-traditional instructional delivery systems)

To improve both applicant selection and yield we anticipate implementing an interview component in our admission process. In this manner, we might have a direct evaluation of the mathematical knowledge of the applicants. Currently, we place too much reliance on students' records and exam scores.

d. actions to improve efficiency and reduce cost

The department could expand our online offering in delivering dual modes (face-to-face and online) graduate courses. This has the potential to increase productivity (more students can take the courses with no time conflict and space restriction, and travel burden). Experience has demonstrated that the demands for the core courses (MASS145 Advanced Linear Algebra and Matrix Theory (3 credit hours); MAT 5712 Scientific Computing (3 credit hours)) has been maintained at high level over the last few years. This path is not without difficulties as there are pedagogical and content issues in online graduate education that will present challenges to expansion.

e. other opportunities not addressed above