Mathematics — Strategic Goals and Action Plans

Goal #1: The mathematics department will increase the number of tenured and tenure-track faculty to 35 in the next five years (recommendation #23).

The review team has given a careful evaluation of FAU's Department of Mathematical Sciences, outlining its strengths and weaknesses, and providing a long list of helpful recommendations. The department appreciates the reviewers' recognition of its accomplishments and the fact that, despite very limited resources, the department continues to accomplish its mission remarkably well. The department also appreciates the reviewers' thoughtful recommendations as blueprints for its improvement and will address them as part of six primary goals in this action plan.

The most important recommendation on the list (and the most urgent from the point of view of the department) is the last, to increase the size of the tenured and tenure-track faculty in the department to 34-36. The reviewers indicate that this number is derived from faculty sizes at comparable universities with similar missions, and thus they correctly point out that FAU's mathematics department is currently far too small. With several retirements of tenured professors imminent (including another at the end of the current semester), the department is in danger of falling below the critical mass needed to sustain its healthy doctoral program on which the research and teaching missions of the department rely heavily. A strong mathematics department is crucial both as a support for all of the pillars of the university's new strategic plan and as a key partner in FAU's strategies for addressing the State University System of Florida's Board of Governors performance metrics.

The department emphasizes that all of its other goals (responses to the other recommendations of the review team) depend upon having sufficient faculty to effect the indicated changes. With this in mind, the mathematics department proposes to hire three tenure-track faculty per year for the next five years. These hires will be focused primarily on addressing the needs of the department as it seeks to support the pillars of FAU's research plan and contribute to the improvement of FAU's performance metrics.

Goal #2: The mathematics department will pursue new initiatives to increase student success in mathematics classes (recommendations #1-8).

The current ALEKS placement test has been used since 2008, and the cut scores for placement into particular courses were adjusted over the first few years. The department has some data on the efficacy of the ALEKS placement test in two courses, from recent studies commissioned by the director of the Math Learning Center (Methods of Calculus, attached as "MAC 2233 Study," and Calculus-Analytic Geometry 1, attached as "MAC 2311 Study"). The data for these two courses seem to indicate that the current ALEKS cut scores are not out of line. One way to improve placement would be to use only proctored attempts at the ALEKS test; the department will continue to push for this change. Another improvement, in placement for Calculus-Analytic Geometry 1, would be to utilize a more refined reading of the test score, separating out the geometry/trigonometry section, which is available from ALEKS. (Currently only the combined

score on all sections of the test is used for placement, and students with no background in trigonometry can nevertheless place into Calculus-Analytic Geometry 1 with a sufficiently high score on the other sections.) More resources are needed for data collection and further study of the effects of these proposed improvements.

One thing noted in the MAC 2311 study is that students who took the prerequisite more than a year before attempting calculus had a 10% lower pass rate than other students. (In a similar context, ALEKS placement scores are now valid for six months only, to make sure that they reflect students' current understanding.) Students who have credit for prerequisites cannot be required to repeat those prerequisites, so in order to address the issue of these unprepared students, the department has run a boot camp, prior to the start of each of the last few semesters, primarily for engineering majors who want to be better prepared for their mathematics classes. The number of students taking advantage of this opportunity has been small, but data collected indicate that they have been successful. Expanding this boot camp and making it mandatory for unprepared students could help improve student success in many mathematics courses. More resources are needed for this expansion.

The two studies mentioned above also contain data which show that students have higher DFW rates in these two courses if they took prerequisites at the local state colleges. The mathematics department understands and appreciates the sensitivity of these issues and hence the importance of taking actions which address these issues without provoking a defensive response from the local state colleges. For this reason, the department believes that these discussions need to be initiated at the provost level. Thus, the department chair and the director of the Math Learning Center recently met with Dr. Jennifer Peluso, Assistant Provost for Student Success at FAU, to formulate a plan.

The mathematics department intends to leverage its program review to get the ball rolling on a small-scale curriculum summit with Broward College and Palm Beach State College, inviting them to help address the recommendation for coordination in a mutually beneficial way. This should minimize any defensiveness on the part of FAU's partner institutions. The department believes that the most productive way to do this would be to focus the discussion on a specific course, College Algebra (MAC 1105), which is a high-stakes course for all of institutions. The mathematics department would like to share how it utilizes ALEKS in this course; the faculty would also like to hear from the BC and PBSC faculty about their own most promising "best practices" for College Algebra. The hope is that such a discussion will lay the foundation for continued discussions about other courses and about curricula overall. An aspirational outcome would be to establish and sustain a process for continued collaboration toward enhancing curricular alignment. The department will make every effort to ensure that this summit not be a forum for discussion only, but that it also produce actionable outcomes that we can assess for effectiveness in improving student success.

Dr. Peluso has already contacted associate provosts at the Broward and Jupiter campuses of FAU in order to elicit ideas for the scheduling of this summit and to solicit their help in contacting their counterparts at the various campuses of BC and PBSC.

The department recognizes that careful coordination in pre-calculus courses seems to have had a positive impact on student performance in these courses. At a meeting on March 17, 2015, the department agreed to begin closer coordination of Calculus-Analytic Geometry 1 (MAC 2311) beginning in fall 2015, and the new chair has appointed Dr. Vincent Naudot, associate professor in the mathematics department, as coordinator of this course. In order to achieve consistent measures of learning outcomes, Dr. Naudot will implement a common final exam with common grading, in order to guarantee coordinated assessment across all sections of the course.

The Math Learning Center (MLC) was staffed entirely by graduate teaching assistants from the mathematics department prior to the current semester, when a small amount of funding was provided to hire a few undergraduate tutors. The MLC has become increasingly busy over the last few years as a popular source of help for struggling students, with referrals from the department chair as well as individual instructors, and hence the MLC has become increasingly understaffed. Additional funding for more undergraduate tutors at the MLC has the potential to make a large impact on student success in mathematics courses.

The mathematics department maintains three instructional computer labs, with funding recently approved for computers for a fourth lab (although no room for this lab has yet been found). The department staffs these instructional computer labs with undergraduate tutors, with funding included in its current budget. Student success rate in the courses using these computer labs, Intermediate Algebra (MAT 1033), College Algebra (MAC 1105), and Introductory Statistics (STA 2023), has improved over the years and is currently very good. The new instructional computer lab will be used for Methods of Calculus (MAC 2233), a course with a stubbornly high DFW rate over the last few years. A room to house this new lab is needed, and additional funding for more tutors to staff this lab is required before it can be used to address problems with MAC 2233.

A pilot trial of the "Learning Assistant" (LA) program was made in fall 2014 in two sections of Calculus-Analytic Geometry 1 (MAC 2311), another course with a stubbornly high DFW rate over the years. Results of this trial indicate that the LA program could have a significant impact on student success, although the amount of data was limited. In the current semester, the program has been extended to include Calculus-Analytic Geometry 2 (MAC 2312), for eight sections total. The department has agreed to a larger trial in fall 2015 encompassing both of these courses, with common final and common grading, in order to test the efficacy of the LA program and, if successful, to convince more faculty to participate in future semesters. Funding for the LA program for 2015-2016 has been requested and is pending.

Thus, in order to employ more undergraduate tutors and learning assistants, the mathematics department needs significantly more funding.

Attracting more students into the undergraduate honors program can stimulate more interest in doing mathematics and improve student performance. In recommendation #6, the reviewers advise the department to remove all requirements listed under "enrichment" and changing the "capstone" to an honors thesis only, in the "Honors in Mathematical Sciences" program (attached proposal "Mathematics Honors"). Given the current University Honors Manual (three pages attached as "Honors Guidelines"), this is not possible. According to the University Honors

Manual, all programs must have an enrichment section in addition to the capstone requirement, so the enrichment requirement cannot be eliminated. Moreover, giving students multiple ways to satisfy these requirements makes the honors program more flexible and opens it up as an option to more students. Therefore, no action will be taken on this recommendation.

Offering required coursework more often can have a positive impact on graduation rates. As of the current academic year, all required courses for the BA and BS in Mathematics degree programs are offered at least twice per year, and most are offered three times per year. For the Minor and Certificate in Statistics programs, the only required course currently offered once per year is Applied Statistics 1 (STA 4234), while for the Certificate in Actuarial Science program, the required courses currently offered once per year are Probability and Statistics 2 (STA 4443) and Actuarial Mathematics 1 and 2 (MAP 4172 and 4173). Enrollment in these courses has not been sufficient to warrant offering them more than once per year for minor or certificate programs, but with the establishment of an undergraduate major in statistics (see goal #4 below), anticipated in fall 2016, these courses and certain others will have to be offered more than once per year. Eventually additional faculty will be needed to teach additional sections of these courses, and, until enrollment in the BS in Statistics degree program reaches an appropriate level, permission will be needed to allow low-enrollment sections of these courses.

The department is in full agreement that the standards of a university education must not be compromised, and other strategies must be used to raise pass rates in mathematics classes. The mathematics department recognizes its responsibility to encourage student success in all of its courses. The department has implemented a number of measures and will continue to seek improvements, as outlined above. The department also recognizes the need to increase faculty engagement in teaching (recommendation #8). The department appreciates the confession of the reviewers that there are no easy solutions to this problem.

The suggestion of self-assessment of teaching during the faculty evaluation process is certainly intriguing and worth trying. To make this self-evaluation more honest (and hence more useful to the individual faculty members), the department proposes to develop a list of "guidelines for effective teaching." These guidelines will be developed by the department's master teacher and the faculty evaluation committee, as a list of suggestions for good teaching practice, and they should provide structure to the teaching self-evaluation by including a list of corresponding questions. For example, a self-assessment question might be phrased as follows: "Department guidelines emphasize importance of students receiving regular feedback. What measures did you take to ensure that students were informed of their standing in the class (e.g., posting grades on Blackboard, calculating and informing students of their class rank, posting a projected letter grade well before final exams)?" By asking faculty to give concrete examples of their effective teaching practices, these guidelines will encourage faculty to think about how they teach and what they might do to improve their students' success.

Goal #3: The mathematics department will expand its undergraduate and graduate recruitment activities (recommendations #9-11).

Increasing the number of mathematics minors is an important goal for the department. Hence, the department's undergraduate committee will consider ways to simplify the minor and make recommendations to the department. The program was designed years ago in such a way that most engineering majors could complete a mathematics minor by taking one or two additional mathematics courses. Over the years, the engineering programs dropped some of the mathematics courses from their curriculum, in response to the Florida statute which stipulates that "a baccalaureate degree program shall require no more than 120 semester hours of college credit," and hence it is no longer so easy for many engineering majors to complete a mathematics minor. The problem is compounded by the "Excess Hours Surcharge," which for students entering the university beginning fall 2012 and thereafter costs an additional 100% for credits above 110% of the program. Therefore, it has become expensive for a student to add a second major or switch degree program. The situation is further complicated by the state's metrics for university funding which emphasize six-year graduation rates, so that advisors currently discourage students from pursuing a second major or switching degree programs. The department will consider ways to adapt the mathematics minor program to be more attractive to majors from other colleges, such as business and science.

The mathematics department especially appreciates the recognition by the review team that its outreach programs are as strong as any in the state. The recommendation for further activities is noteworthy; indeed a few faculty have already suggested expanding the Math Students' Circle to elementary school students as well as to high school students. Given that FAU is recognized as a "Hispanic Serving Institution," there have also been discussions about organizing a conference for undergraduate minorities in mathematics along the lines of the very successful "Nebraska Conference for Undergraduate Women in Mathematics." It is worth repeating that an expansion of outreach efforts can only be accomplished through a corresponding increase in the number of tenure-track faculty in the mathematics department, as the department simply does not have sufficient resources to undertake new outreach initiatives.

As a further recruitment tool, the department will also adjust the department webpage and the university catalog description in order to better reflect the goals of the program. FAU is in the process of updating all of its webpages, one college at a time. The Charles E. Schmidt College of Science is mostly finished with revisions to its main website but is waiting for the Office of Information Technology (OIT) to make certain structural changes before the new college website can go live. The Department of Mathematical Sciences made extensive revisions to its webpages nearly a year ago but awaits action by OIT before these changes can be effected.

Goal #4: The mathematics department will restructure its degree programs in order to provide more interdisciplinary opportunities, secure more internship positions, and enhance the career options of its majors (recommendations #12-16).

Data from the Florida Education and Training Placement Information Program for 2012-2013 (attached as "FETPIP 2013-2013") indicate that FAU's BA and BS programs in mathematics compare favorably with others in the state. For example, FAU graduated approximately the same number of bachelor's degrees in mathematics that year as UCF, even though UCF has twice the enrollment of FAU, and the percentage employed and average quarterly earnings are

slightly higher for FAU graduates, while the percent continuing their education is slightly lower for FAU graduates. Overall, it appears that FAU's undergraduate degree programs in mathematics are as effective as other such programs in the state. Thus, the consensus of the department is that the BA and BS degree programs can (and will) be improved, but it is neither necessary nor desirable to remake the programs from first principles, as recommended by the review team. Changes will be implemented carefully, following the outlines of the 2015 CUPM Curriculum Guide to Majors in the Mathematical Sciences.

As recommended by the reviewers, both the department webpage and the university catalog will be amended to include mention of the importance of VEE coursework for the actuarial science certificate. The mathematics department currently has three active VEE courses listed on the soa.org website: Applied Time Series (STA 4930), Applied Time Series Analysis (STA 6857), and Honors Econometrics: Applied Regression Analysis (ECO 4412). Several other VEE courses from FAU's mathematics program were approved in the past but their approval has lapsed; the department will resubmit applications for these courses immediately. Moreover, it is worth mentioning that the list of required coursework for the statistics minor and certificate programs do include components reflecting the use of statistics in engineering (STA 4032, STA 4821, and EEL 4541), data science (STA 4102 and STA 4103), physics (PHY 4523), economics (ECO 4422) and business (STA 4852).

The document indicated in recommendation #13 was not forwarded to the department, but the current attachment ("FCAS") appears to be the "state mandated Common Program Prerequisites" for undergraduate mathematics programs. The department's undergraduate committee will examine this document and forward its recommendations to the mathematics department for immediate consideration.

The mathematics department has already approved a proposal for a BS in Statistics degree program, with the goal of launching this program in fall 2016. The program has been designed with reference to the 2014 curriculum guidelines for undergraduate programs in statistical science of the American Statistical Association, as recommended by the review team.

The mathematics department currently has in place an Applied MS degree with a Biostatistics track, and the departmental graduate committee will look into options for transforming this program into an MS degree in Statistics—offering a broader choice in topics. Given the already existing graduate-level coursework in statistics, introducing such a degree should be possible within two years.

As noted by the reviewers in their report, several additional faculty will be needed to meet the needs required by these new degree programs in statistics.

FAU's Career Development Center already gives regular presentations to mathematics graduate students, and the department will invite the center to give presentations to the undergraduate Math Club as well. Thus, the mathematics department can build on this existing contact to work with the center to identify potential employers and internship opportunities. Moreover, the mathematics department will leverage the existing partnership of FAU's Center for Cryptology and Information Security with FAU's Research Park to identify local internship opportunities

and invite the Park administration to send a representative to speak to mathematics students. The students will be made aware of opportunities for internships and part-time and full-time employment with Park occupants. The Charles E. Schmidt College of Science Advisory Board is another logical resource for identifying plausible strategies to improve outreach to regional players.

To advance the preparation of our students for industry needs, a course within the competitive PIC program (Preparation for Industrial Careers in Mathematical Sciences) is already planned for spring 2016. Utilizing these starting points, the department expects that the development of an outreach program can be catalyzed, which will be among the priorities of the mathematics department.

Goal #5: The mathematics department will encourage its faculty to attempt to obtain more research funding (recommendations #17-18).

Substantial incentives—like a reduced teaching load—are contingent on the availability of resources. Lacking additional resources, the department will nevertheless try to ensure that successes are appropriately publicized, e.g., through established university newsletters. Moreover, in course assignments, faculty who are particularly successful in their research may occasionally be given preference in the teaching of advanced courses which are likely to attract Ph.D. students.

The departmental administration, in coordination with the associate dean for research, will foster productive contacts between faculty members and appropriate personnel of the Division of Research, with a view to identify possible sources of funding (especially for larger projects), as well as opportunities for cooperation in grants across departmental and college boundaries. Substantial support would require additional resources—e.g., a staff hire, as well as support from the college or university. The department will make available mathematical capabilities more transparent to the Division of Research, so that the departmental strengths can be considered appropriately in university-level project efforts.

Goal #6: The mathematics department will encourage integration of mathematics into the teaching and research of other areas of the university, in order to stimulate more interdisciplinary activity in the department (recommendations #19-22).

The department will broaden its course offerings in order to emphasize the applicability of mathematical techniques in other disciplines. It is worth repeating that any significant increase in the number of mathematics courses offered can only be accomplished through a corresponding increase in the number of tenure-track faculty in the mathematics department. Absent any increase in resources, the department has already begun several initiatives which will provide more course offerings emphasizing applications of mathematics.

- As mentioned above, the department is completing a proposal for a BS in Statistics degree program. With the expected enrollments in this new degree program, the department will be able to offer additional upper-division statistics courses not recently offered because of

insufficient demand, including Computational Statistics 2 (STA 4103), Applied Statistics 2 (STA 4702), and Statistical Designs (STA 4222).

- Honors sections of Methods of Calculus (MAC 2233) and Calculus-Analytic Geometry 1 (MAC 2311) have been commissioned by the University Honors Council and are under development for fall 2015 and spring 2016, respectively. Because of the large number of biology majors in the undergraduate honors program, these honors classes will be designed to focus on mathematical models in biology.

- Because of declining interest among engineering departments for requiring Engineering Mathematics 2 (MAP 4306) as part of their degree programs, the chair of the Engineering-Mathematics Liaison Committee has begun exploring the possibility of replacing this course by Differential Equations 2 (MAP 4303), another course not recently offered because of insufficient demand. The mathematics department is consulting with the departments of physics and geosciences to build a course in partial differential equations with applications to the physical sciences as well as engineering.

With additional faculty, the mathematics department can further broaden its course offerings to include new undergraduate courses in biomathematics, mathematical physics, and applications to economics and finance.

In order to increase the visibility of the mathematics department, successful outreach activities, such as Math Day and the Math Circles, will be continued, and the department will make regular use of existing FAU publications (like newsletters) to highlight departmental achievements and student successes. In addition, the department will work with the FAU foundation to improve the visibility of the mathematics department in the region.

The mathematics department will invite center directors and department chairs, individually, to give talks to the mathematics department about their respective centers or departments, so that collaboration opportunities can be identified. Moreover, the mathematics department already has existing interdisciplinary collaborations, whereby experienced faculty can help new hires to connect with other departments and centers.

Through interaction with the Division of Research, department chairs, and directors, the administration of the mathematics department will help in identifying interdisciplinary grant opportunities. Especially for young faculty, the department will provide mentoring and guidance in preparing project budgets that cross departmental boundaries. The department, including its budget manager, has experience with such budgets and a good working relationship with the Division of Research, so that the department can try to minimize administrative overhead.