GEORGE MASON UNIVERSITY

Graduate Council NEW Certificate, Concentration, Track or Degree Program

Coordination/Approval Form

(Please complete this form and attach any related materials. Forward it as an email attachment to the Secretary of the Graduate Council. A printed copy of the form with signatures should be brought to the Graduate Council Meeting. If no coordination with other units is requires, simply indicate “None” on the form.

Title of Program/Certificate,etc: Mathematics

Level (Masters/Ph.D.): Ph.D.

Please Indicate: __X__ Program ____ Certificate _____ Concentration ___ Track

Description of certificate, concentration or degree program:

Please list the contact person for this new certificate, concentration, track or program for incoming students:

David Walnut, Professor and Graduate Program Coordinator, 703-993-1460,
dwalnut@gmu.edu

Approval from other units:

Please list those units outside of your own who may be affected by this new program. Each of these units must approve this change prior to its being submitted to the Graduate Council for approval.

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Submitted by: ____________________________________________  Email: ____________

Graduate Council approval: _________________________________  Date: _____________

Graduate Council representative: _____________________________  Date: _____________

Provost Office representative: _______________________________  Date: _____________
# PROGRAM PROPOSAL COVER SHEET

1. Institution: George Mason University

2. Program action (Check one):
   - Spin-off proposal
   - New program proposal __X__

3. Title of proposed program: Ph.D. in Mathematics

4. CIP code: 40.0101

5. Degree designation: Ph.D.

6. Term and year of initiation: Fall 2005

7. Term and year of first graduates:
   - Spring 2008

8. For community colleges: date approved by local board

9. Date approved by Board of Visitors

10. For community colleges: date approved by State Board for Community Colleges

11. If collaborative or joint program, identify collaborating institution(s) and attach letter(s) of intent/support from corresponding chief academic officers(s): The degree is offered only by George Mason University.

12. Location of program within institution (complete for every level, as appropriate). If any organizational unit(s) will be new, identify unit(s) and attach a revised organizational chart and a letter requesting an organizational change (see Organizational changes--hotlink).
   - School(s) or college(s) of College of Arts & Sciences
     - Campus (or off-campus site) __Fairfax campus__
     - Distance Delivery (web-based, satellite, etc.) ____________

13. Name, title, telephone number, and e-mail address of person(s) other than the institution’s chief academic officer who may be contacted by or may be expected to contact Council staff regarding this program proposal:
   - Dr. Robert Sachs, Professor, Chair Department of Mathematical Sciences 703-993-1462, rsachs@gmu.edu
A Proposal for a Ph.D. in Mathematics

Presented by the

College of Arts and Sciences

February 13, 2004
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1. EXECUTIVE SUMMARY AND BACKGROUND

The College of Arts and Sciences (CAS) proposes a Ph.D. program in mathematics. While mathematics has always played a fundamental role in quantitative understanding, its importance is perhaps greater now than ever before. Mathematics is flourishing, pursued for its own sake and for its applications. The areas where mathematics is used are growing and the level of mathematics used in applications is deeper. Topics that were thought to be esoteric pure mathematics often turn out to be crucial and unanticipated aspects of solving a problem, while the role of more clearly applied areas remains vital. For example, knot theory has become important in DNA analysis, data encryption relies on number theory, and modern finance relies on the theory of stochastic differential equations. One GMU mathematics professor was involved in research concerning inkjet printers and the melting and cooling of complex solids, while others have made contributions to the understanding of complex brain wave patterns in epilepsy. Computational advances have had an impact on many areas, including mathematics, but these advances come with an increased need for mathematical insight to cope with data, formulate models, and make predictions. In many fields, progress is enhanced by collaboration with a mathematician. Therefore, we believe that a doctoral program in mathematics at George Mason University will be valuable for Northern Virginia and beyond, and will enhance other doctoral programs.

This new degree builds on the strengths of the faculty and their research relationships with other George Mason faculty, other institutions, and industry. The faculty in the department is actively engaged in research in pure and applied mathematics. External funding, publications, and international collaborations, including a current visiting Fulbright scholar from Spain, a visiting doctoral student from Norway, and a visiting Japanese professor on sabbatical next year, attest to the high quality of the research faculty at George Mason and their growing reputation. The GMU faculty is highly qualified to train future mathematicians in academia and in industry, who are expected to be in demand locally, nationally, and internationally. Our past success in preparing undergraduates who have gone on to succeed at respected doctoral programs elsewhere and our doctoral student experience in the School of Computational Sciences, which has a number of students in Computational Mathematics, show that the faculty has the needed knowledge and experience to develop a high-quality program.

Recent data from the American Mathematical Society (AMS) indicates that nearly all doctoral recipients are employed. Academic jobs are usually listed via the AMS EIMS web page, currently showing 328 listings. Industry hires about 25% of all mathematics Ph.D.s; the National Security Agency (NSA) is the largest single employer of Ph.D.s in mathematics. Locally, companies are enthusiastic about hiring mathematicians. Indeed in the last eight years, three GMU math faculty members were lured into industry. Two of them had scant training in the areas they now work in. As career paths become more fluid, individuals with mathematics backgrounds can often make transitions to other fields. For example, in biology, Eric Lander (MIT), now one of the world’s leading experts in genomics, has a mathematics doctorate, as does one of GMU’s current bioinformatics professors. The potential of industrial mathematics is discussed at SIAM’s Mathematics in Industry page www.siam.org/mii/ and Mathematics: Giving Industry the Edge, a report from the Smith Institute (UK) www.smithinst.ac.uk/news/RoadmapLaunch.

The GMU Math external industry advisory group was very enthusiastic about the local hiring of graduates of the proposed program who had prepared themselves wisely. When asked directly, they were very clear that there is a
specific need for doctoral level graduates. Their corporate experience includes small companies as well as very large firms. Local support for this effort is documented in an appendix, and includes letters from two other GMU programs that collaborate in research (Vernon Smith, Economics and Steven Schiff, Neurobiology) and also from some members of local industry on our advisory group.

Students for the program will come from recent undergraduates within Virginia and nationally and internationally, as well as from local residents, many working in industry already. The current degree combination (MS in Mathematics, Ph.D. in Computational Sciences and Informatics) is not as attractive to potential students as the new doctoral degree is likely to be. International connections are already somewhat established. In addition to the ones mentioned above, there are now two Italian doctoral students in Computational Mathematics and developing interactions in Germany, Japan, China, Israel, Iceland, Great Britain, Mexico, Sweden, and the former Soviet Union.

A doctoral degree program in mathematics will have several positive effects on the GMU community and on Northern Virginia. It will expand mathematical research opportunities. Current external funding through agencies such as the NSF and NIH, which support faculty and their students on a competitive basis, will grow more rapidly as more of their programs become possible funding sources. Faculty recruitment will be enhanced. Other doctoral programs at GMU will benefit through collaborative research, advanced training for doctoral students outside mathematics, increased contacts with other universities, and greater opportunities for external funding of interdisciplinary work. Mathematics teachers in K-12 and community college institutions may seek additional mathematical training as well, enhancing current interactions. Researchers outside GMU in government and industry may collaborate in doctoral training and research. As well, mathematics students and doctoral students in physical sciences, life sciences, engineering, and economics will benefit greatly from their interactions with mathematics students, forming a larger, more vibrant graduate community at GMU.

2. DESCRIPTION OF PROPOSED DOCTORAL PROGRAM

2.1 Mission: The proposed doctoral program will train mathematicians for further research, high-level teaching, and industrial employment. Students will have a solid grounding in mathematics, be exposed to contemporary problems and applications, use computational tools where appropriate, and be prepared to collaborate with others.

2.2 Summary of requirements: The degree program requires 72 graduate hours beyond an undergraduate degree, of which at least 48 are course requirements, and culminates in a doctoral dissertation. There are two sets of exams, in addition to the dissertation defense. Students who already possess a M.S. degree or other graduate work may receive up to 30 credit hours towards the degree. Additional requirements include 4 specified core courses, two areas of emphasis, and participation in advanced seminars, all as described below.

2.3 Beginning study, required core courses and preliminary exam

For the first two years, a typical full-time student will take coursework including the four core courses to be tested in the preliminary written exams. The preliminary exams must be passed by the end of the student’s third year. Currently, the required courses are Math 621 (Algebra), Math 631 (Topology), Math 677 (Ordinary Differential
Equations), and Math 675 (Linear Analysis). This requirement ensures a basic competency in each of the four areas of specialization and forms the foundation for later studies.

The exam will be based on material presented in three of the four required courses (the student may choose which topic to exclude). These exams are offered two times a year (prior to spring semester, and at the end of the summer.) Students may take the exam as often as they like (within their first three years) but they must have finished the coursework (or waived the requirement) before taking the exam. The exam will be created and graded by the professors who most recently taught the core courses, and their efforts will count towards department service. The results of the exam will be: “Unsatisfactory”, “Conditional”, or “Pass”. “Unsatisfactory” suggests a student did poor work in two or three of the topics tested. If a student receives an “Unsatisfactory”, he or she must retake the entire exam. “Conditional” suggests that a student did poor work in one of the topics tested. In this case, a student must retake the test in only the failed topic (or in the untested topic), and will have such an opportunity at the next time the preliminary exam is offered. If he or she passes this one topic subsequently, the “conditional” status will be changed to “Pass”. “Pass” suggests that the student has a working knowledge of all three topics and may continue to meet the other requirements of the PhD program. A grade of “Pass” on the preliminary written is also sufficient to satisfy the creative component of the Master's Degree in mathematics.

2.4 Advancing to candidacy and the qualifying exam

By the end of the fourth year, students will take a qualifying exam. The qualifying exam has both an oral and a written component. The oral component of the exam will typically last about two hours. The written exam format will be determined by the examining committee.

As soon as possible after the preliminary exams, a student will choose an advisor who will help to shape the major program of study for the qualifying exam. In preparation, he or she will study material in a deeper way, with an eye toward an eventual research topic. A student will also choose a committee, who will examine the student, as well as having an informal advisory role in the student’s education. The composition of the committee must be approved by the advisor and the director of graduate studies. The members will not only examine the student, but are also expected to take an interest in the student’s progress and act in an informal advisory role throughout the student’s time at George Mason.

For the qualifying exam, students are expected to master one topic at a sufficiently deep level to be judged ready to do research in this topic. We call this topic the major area. They are additionally required to understand another topic at an advanced level comparable with several semesters of graduate work. We call this topic the minor area. The expectation is that the amount of material a student is expected to know in the major area is equivalent to approximately four courses (including an introductory course if one exists), and in the minor area approximately three courses of material. The specific topics constituting a major and minor area are left quite flexible (although they must be distinct from each other, as described in the next paragraph). It is expected that they will vary widely depending on the individual student, advisor, committee, and research area. The preparation work in the major and minor areas may be done as part of independent studies or reading courses.
The major and minor areas must be in two different areas of mathematics. For the purposes of clarifying distinct areas for the major and minor topics, courses are divided into the following four specialization areas, corresponding to the research areas of the department:

(i) Topology and Geometry

(ii) Applied and Computational Mathematics

(iii) Algebraic Structures, Combinatorics, and Optimization

(iv) Potential Theory and Harmonic Analysis

For example, a student may study convex geometry as a major area (in the Topology and geometry specialization) and commutative algebra as a minor area (in the Algebraic Structures, Combinatorics, and Optimization specialization). A student cannot have a major in convex geometry and a minor in topology since these topics are in the same area of specialization. When appropriate (such as in applied major fields), the student may choose a minor field outside the department. A small number of courses may be chosen as topics in more than one area of specialization. For example, Algebraic Topology may be a topic in Topology or a topic in Algebra, but it may not be used for both in the same exam.

The grade on the qualifying exam will be “Pass,” “Conditional,” or “Unsatisfactory.” The oral component and written component are graded as a whole. If a student receives an “Unsatisfactory,” they are allowed to retake it once approximately six months later, at which point they must at least have received a “Conditional.” A “Conditional” may either require retaking the entire test, or retaking a portion of the exam with restricted topics, as determined by the committee. These conditions should be given to the student when the committee determines the “Conditional” score.

These three committee members remain the same from the qualifier to the defense. Should the student choose to change the committee, it must be done in writing more than a month prior to the defense of the thesis, subject to the approval of the director of graduate studies.

Approximately one semester after passing the qualifying exam, each doctoral student prepares a written dissertation proposal while taking Math 998 (doctoral Dissertation Proposal). The proposal must be approved by the thesis committee.

The thesis committee consists of the three qualifying exam committee members and a fourth member who must come from outside the department (as required by the university guidelines for doctoral students). After successfully completing this requirement, the student advances to candidacy for the Ph.D. Degree.

2.5 Thesis and Defense

After advancing to candidacy, a student will work on a doctoral dissertation while enrolled in Math 999. The dissertation is a written piece of original thinking which demonstrates a doctoral candidate’s mastery of the subject matter. A student is expected to produce new and original research worthy of publication in a peer-reviewed journal. After the thesis is completed, the committee will review the thesis and examine the student in a public oral thesis
defense. Students are typically expected to finish the thesis within two years of advancing to candidacy.

2.6 Additional requirements and restrictions

Grades in the core courses: Students must earn a B or better in each of the four core courses. If a student has already completed equivalent coursework elsewhere, he/she may meet this requirement by receiving appropriate transfer credit or taking an (approved) advanced course in the field (and earning a B or better). Students are still required, however, to pass the preliminary exams.

Seminar: Students must attend a 1-credit mandatory weekly student seminar. This seminar is graded on presentations and attendance. It consists of both faculty presenting potential thesis topics and presentations by students (on topics that they choose with faculty guidance, but not necessarily on research). Each student will give a presentation each semester and will receive comments by an assigned faculty discussant. All faculty interested in having PhD students will periodically be discussants and will present topics to the students.

3. EVALUATION OF PROGRAM EFFECTIVENESS

3.1 Student assessment

Upon completion of the program, each student will be expected to have successfully completed all of the goals listed below. The achievement of these benchmarks will be determined by successful completion of coursework, the dissertation research, the dissertation defense, and the written and oral exams, as described in the previous section.

- Understand and apply core concepts of mathematics
- Develop expertise in a specialized research area
- Pose a mathematical research question and conduct original research to answer it
- Communicate mathematics effectively in written and oral forms
- Participate actively as a member of a mathematics seminar
- Abide by the values and ethics of the mathematics community
3.2 Evaluation of Program Effectiveness

The effectiveness of the proposed program will be judged in several ways. The major criterion will be the continued graduation and employment of Ph.D. students. We anticipate that the graduation rate will be comparable with those established in other mathematically oriented degree programs here and elsewhere in Virginia and that students who desire employment will find it. A second measurement will be student enrollment. If the program fails to meet enrollment targets, a vigorous effort will be made to attract such students nationally and internationally. We will also assess whether the focus of the program is in keeping with student demand and interest, or whether a re-direction is desirable.

If the program fails to meet criteria for enrollment and graduation rates, a panel of experts will be invited to review and recommend improvements to the program. Additionally, every five years a panel consisting of both GMU faculty and external faculty from other mathematical sciences programs will be assembled to review the progress of the program and comment upon areas of possible improvement. The comments of the panel will be analyzed and used in making strategic decisions for the advancement of the program.

4. JUSTIFICATION FOR PROPOSED Ph.D. PROGRAM

As described briefly in the executive summary above, the growing importance of mathematics and the widening range of applications increase the benefits of a doctoral program to the university and Virginia. The GMU faculty are capable researchers with a widening international reputation, ensuring quality in the program and helping attract students and external funding support. The positive local industrial environment and the cooperative relations with other doctoral programs at GMU and mathematics programs elsewhere enhance the likelihood of success. Details are provided below, along with some information on national trends, other programs in Virginia, and projected enrollments.

The proposed Ph.D. Program in Mathematics is a response to current needs and projected future needs. As discussed elsewhere, the presence of an energetic mathematics doctoral program has many benefits to other doctoral programs in technical fields and is of great interest to local industry.

4.1 Mathematics as a contemporary discipline

Numerous national reports and significant anecdotal evidence attest to the importance of mathematics both as a discipline within itself and as a partner with other disciplines in tackling large, important problems. While the centrality of mathematics in academia dates back to Plato’s Academy at least, recent trends outside academia as well as mathematics used in interdisciplinary academic research have made a vital mathematics program even more valuable to universities. Support for mathematics research from the National Science Foundation has increased, and the National Institutes of Health has expanded its efforts in mathematical research funding. Interdisciplinary efforts include traditional applications in the physical sciences and engineering, but also include life sciences and medicine, economics and finance, computer and communications security, and social science modeling. Data often comes in extremely large quantities and mathematical models are often essential for coping with the information and extracting useful parts. Some industrial problems are amenable to mathematical attack, usually combined with

We quote briefly from a very recent NSF program announcement as part of their Mathematical Sciences Priority Area:

> Today's discoveries in science, engineering and technology are intertwined with advances across the mathematical sciences. New mathematical tools disentangle the complex biotic and abiotic processes that drive the climate system; mathematics illuminates the interaction of magnetic fields and fluid flows in the hot plasmas within stars; and mathematical modeling plays a key role in research on micro-, nano-, and optical devices. Innovative optimization methods form the core of computational algorithms that provide decision-making tools for Internet-based business information systems.

The fundamental mathematical sciences – embracing mathematics and statistics – are essential not only for the progress of research across disciplines, they are also critical to training a mathematically literate workforce for the future. Technology-based industries which help fuel the growth of the U.S. economy and increasing dependence on computer control systems, electronic data management, and business forecasting models, demand a workforce with effective mathematical and statistical skills, well-versed in science and engineering.

It is vital for mathematicians and statisticians to collaborate with engineers and scientists to extend the frontiers of discovery where science and mathematics meet, both in research and in educating a new generation for careers in academia, industry, and government. For the United States to remain competitive among other nations with strong traditions in mathematical sciences education, we must attract more young Americans to careers in the mathematical sciences. These efforts are essential for the continued health of the nation's science and engineering enterprise.

The goal of the Mathematical Sciences Priority Area (MSPA) is to advance frontiers in three interlinked areas: (1) fundamental mathematical and statistical sciences, (2) interdisciplinary research involving the mathematical and statistical sciences with science and engineering, and (3) critical investments in mathematical and statistical sciences that embed training in research activities.

Investments in the Mathematical Sciences will deepen support for fundamental research in mathematics and statistics and the integration of mathematical and statistical research across the full range of science and engineering disciplines. Initial investments in interdisciplinary research will focus primarily on three scientific themes:

- mathematical and statistical challenges posed by large data sets,
- managing and modeling uncertainty, and
- modeling complex nonlinear systems.

These themes provide the basis for most of the interdisciplinary competitions that are part of the MSPA. Innovative educational activities that foster closer connections between research and education in the mathematical sciences will also be supported.
4.2 Faculty expertise

The Department of Mathematical Sciences has 27 tenured or tenure-track faculty, as well as 2 former faculty members now in other units. One of the 27 is jointly appointed with Systems Engineering and Operations Research. All hold doctoral degrees and nearly all are actively publishing mathematical research. The areas of mathematics research covered within the doctoral program are by design precisely those of the faculty.

Faculty members have obtained research grants from the National Science Foundation and from the National Institutes of Health. Nearly all publish research articles in refereed journals and some serve on editorial boards for journals. Several professors have been invited to give special research presentations internationally; locations have included Japan, Germany, Switzerland, Israel, Italy, China, Australia, and the United Kingdom. Some faculty serve on journal editorial boards and are organizers of professional meetings. One faculty member was a Fulbright fellow in Israel, while another is hosting a Fulbright Fellow from Spain.

Currently there are about 5 doctoral candidates from the School of Computational Sciences working with faculty on theses. Faculty have supervised 3 previous doctoral theses in SCS as well as 1 student in the School of Information Technology and Engineering (joint appointment). Math faculty served on many more doctoral committees at GMU and also informally as part of doctoral advising for some students from the University of Maryland, College Park.

Faculty biographical sketches appear in Appendix 3 below.

4.3 Local industrial environment

Northern Virginia and the greater Washington metropolitan area generally has a large number of technical firms who employ highly educated workers. These include some very large corporations such as Sony, AmericaOnLine, General Dynamics, Lockheed Martin, SAIC, IBM, and many smaller entrepreneurial companies. Their interaction with the proposed program would occur primarily either as students graduate and then seek employment with these firms, or when their current employees come to the program seeking additional mathematical training. We are working with local industry to make both of these situations as productive as possible. In particular, the GMU mathematics department recently created an industrial advisory committee to help in our planning for courses, internships, programs, and collaborative research, and to seek where appropriate industry expertise for classroom teaching.

These efforts expand on our prior experiences with undergraduate and masters students in our program as well as doctoral students in the School of Computational Sciences. The pursuit of a doctoral education while employed in a technical field is difficult, but the members of our committee recognize that such study will be good for their companies. As well, they are eager to find graduates with appropriate training to add to their employees. In particular, when asked whether doctoral level is desirable, they were emphatically positive. They estimated that local industry would easily employ ten or more graduates per year if they fit the needs of companies.

A letter from the chair of the industrial advisory committee is in Appendix 1 below.
4.4 Relations with other GMU doctoral programs

For many years the Mathematical Sciences Department has acted in support of existing doctoral programs at GMU. This support takes the form of teaching cross-listed courses, serving on dissertation committees, formal and informal advising of doctoral students, and supervision of PhD theses. The programs that the Department supports in these ways cut across the full breadth of the University structure, and include the College of Arts and Sciences (The Doctor of Arts in Community College Education), the School of Information Technology and Engineering (PhD in Statistical Science, PhD in Systems Engineering and Operations Research) and the School of Computational Sciences (PhD in Computational Sciences). The continuing strength of these interactions shows that strong, advanced mathematical training is essential for vital PhD programs in technical fields.

A PhD program in Mathematics will enhance and expand these interactions. For example, the application of sophisticated mathematical techniques to problems in finance and economics has recently been making rapid strides (see the report on the recent meeting on this topic in Snowbird, UT jointly sponsored by the American Mathematical Society, the Institute for Mathematical Statistics and the Society for Industrial and Applied Mathematics that appeared in the November 2003 issue of SIAM News). The Math Department and the Economics Department are well-positioned to take advantage of this trend. Courses in stochastic differential equations have been run successfully several times and links with local institutions such as the Federal Reserve, Fannie Mae, Freddie Mac, and PBGC already exist. A supporting letter from Professor Vernon Smith, Professor of Economics and Law, is in Appendix 1.

Another example is the emerging importance of mathematics in the biological sciences. This was emphasized in a recent report from the National Academy of Sciences on the future curriculum needs of undergraduate biologists, BIO2010. Mathematics played a key role in the human genome project and in creating models for the spread of epidemics and biohazards. Several of our faculty members are actively participating in the work of the neurosciences group at the Krasnow Institute here at GMU. A letter from Professor Steven Schiff describing joint research is in Appendix 1.

On the other hand, a PhD program in Mathematics will not detract from existing PhD programs at GMU and in fact will be considerably enhanced by such programs. This will take the form of supplying students for course offerings and also of supplying incentive for exposing students to the challenging mathematical research problems arising in other disciplines.

The PhD in Mathematics is not an interdisciplinary program per se and will tend to attract students primarily interested in theoretical rather than discipline specific or purely computational issues. So students interested in a particular discipline will still choose to take a PhD in that discipline and the PhD in Mathematics will not draw students from such programs.

The PhD program at GMU that is closest to the proposed program is the Computational Mathematics track of the PhD in Computational Sciences. Since the start of the program, there have been four PhDs awarded in Computational Mathematics, three of which were supervised by members of the Mathematics Department. There are currently four or five students in the Computational Mathematics track who have been admitted to candidacy or who are close to being admitted to candidacy, and several others who have declared an interest in computational
mathematics but who are further back in the program. However, given the numbers of PhD students in Computational Sciences and the expected size of the PhD program in Mathematics, it seems unlikely that the PhD in Mathematics would have a discernible negative impact on that program. Moreover, the PhD degree in Computational Sciences is quite distinct intellectually from the proposed PhD in Mathematics. The former seeks students interested in research on computational problems in mathematics whereas the latter will necessarily have a more theoretical focus with numerical and discipline specific aspects taking a secondary role.

4.5 Relations with other mathematics programs locally and in Virginia

At present, students wishing to pursue a PhD in Mathematics in the State of Virginia can attend the University of Virginia and Virginia Tech. In addition, the PhD degree in Mathematics is also offered locally at the University of Maryland, College Park, George Washington University and Howard University. The proposed PhD in Mathematics at George Mason University will be sufficiently distinct from these programs, both intellectually and geographically, as to have no negative effect.

The PhD program at Virginia Tech is the largest in the state, with approximately 70 graduate students and producing about 5 PhDs per year. The program at VPI, with the proposed program at GMU, emphasizes the interplay of mathematics with scientific and industrial research while maintaining a solid base in the traditional disciplines. It is clear however that the department at George Mason University is intellectually distinct from that at VPI. The department at George Mason University has a substantial group working in dynamical systems, and has considerable strength in combinatorics and convex geometry. Moreover, substantial interactions with other disciplines, most significantly with the Economics Department and with neuroscientists at the Krasnow Institute, distinguish the department at GMU. At the same time, GMU has a developing collaboration with Virginia Tech through Professor Zietsman, our most recent addition to the faculty. Her research is in computational methods for feedback control of distributed parameter systems. Among her collaborators are several faculty from Virginia Tech, along with Air Force Research Laboratory (Dayton, Ohio) and NASA Langley Research Center (Hampton VA). A letter of support from Professor John Burns of Virginia Tech is in Appendix 1.

Perhaps the most significant distinction is a geographical one. A prospective PhD student in Northern Virginia wishing to stay in the Washington DC metropolitan area would be more likely to consider attending the University of Maryland or George Washington University than VPI. It is this pool of students that the proposed PhD program would be in more direct competition with. Finally, because of the location of GMU in the greater Washington DC metropolitan area, there are greater opportunities for prospective students to encounter and interact with industry and government than elsewhere in the state. It should also be noted that, while VPI does have an extension campus in Northern Virginia, it does not offer a graduate degree in Mathematics.

The PhD program at the University of Virginia is more focused on traditional areas of study in Mathematics, specifically algebra, analysis, topology, mathematical physics, history of mathematics and probability. It is anticipated that most of the students entering the proposed PhD program at GMU would be interested in those areas representing particular strengths of our department, such as dynamical systems, differential equations and computational mathematics. Of course, there is intellectual overlap between the two departments but it is unlikely to affect enrollments at UVA.
The University of Maryland, College Park has the largest PhD program in Mathematics in the Washington, DC area. Many of the students that we anticipate will be interested in the proposed program at GMU would also have some interest in UMCP. Against this possible draw from our program are two significant factors. (1) Most students in the UMCP PhD program are full-time and courses there are offered primarily during the day. Consequently any part-time student based in the Northern Virginia area would find it difficult to attend UMCP and would be likely to choose GMU instead. (2) Any full or part-time student wishing to be located in the Northern Virginia area would find it very difficult logistically to attend classes at UMCP. While the two campuses are geographically close, the realities of commuting to College Park form a considerable impediment. For such a student, GMU is a very attractive alternative.

The PhD program at George Washington University is similar in size and emphasis to the proposed program at GMU. However, it is to be observed that their department is considerably smaller (15 faculty versus 27). Also, George Mason University has considerable independent attractions for graduate students, notably the interactions between the Mathematics faculty and other GMU departments. Consequently the PhD program at GWU should not detract appreciably from the proposed program here.

4.6 National trends in mathematics doctoral education and employment

In 2001-02, roughly 950 doctoral degrees were awarded in mathematical sciences according to the AMS. This includes statistics and operations research programs (about 250 degrees were in statistics or biostatistics). Over the past five years or so, degrees awarded has declined from just less than 1200 in 1997-98. About half of recent degrees are awarded to U.S. citizens, compared to a figure of about 75% in the mid-1970s. Slightly over 30% of new doctorates were female.

Recent doctoral recipients in mathematics seem to be finding employment. Fall 2002 (latest data) showed that 2.9% of new doctoral recipients were unemployed, the lowest figure since 1990. In 1994 and 1995, for comparison, 10.7% were in that category. This was probably due to economic situations along with an influx of mathematicians from the former Soviet Union and other part of Europe. The forward outlook is for continued employment opportunities in academia and industry. In academia, overall faculty age leads to increased retirements while university enrollments are increasing. In industry, demand appears to be increasing. Academic jobs are usually listed via the AMS EIMS web page, currently showing 328 listings. Some of these listings are for more than one position. Industry jobs are more widely dispersed and there is no central site for compiling data on their number.

The Carnegie Initiative on the Doctorate has recently led to publications addressing the mathematical community on the future of the doctorate in mathematics (Notices of AMS, August 2003 and September 2003). The GMU Math department expects to participate in an evolving discussion on doctoral mathematics and to maintain its openness to a broad view of mathematics and the roles and careers of mathematicians.

4.7 International mathematical collaborations

The GMU Mathematics department has a growing international reputation. Specific links exist with a number of other universities, as described above. At present, despite no funding on our part, we have a visiting doctoral student from Norway, a visiting Fulbright scholar from Spain, and in the coming year we will host a professor from
Japan who will be on sabbatical. Each of these visitors is interacting with a different set of researchers here, which shows the breadth of our research strength.

An institutional agreement with the University of Augsburg in Germany is pending, once the doctoral program here is underway. Other formal exchange programs will be explored. Mathematical colleagues in Italy, Great Britain, Australia, Canada, Japan, Germany, Israel, Russia, Mexico, China, Singapore, Moldova, and other countries will be contacted and potential graduate students identified and encouraged. As well, George Mason’s hosting of the International Mathematical Olympiad in 2001 has introduced a number of younger students and influential educators from 85 countries to the university.

4.8 Projected enrollments

Students are expected primarily from three sources: locally (current GMU undergraduates plus local residents), within Virginia (not GMU undergraduate and not living near GMU), and nationally and internationally. Based on recent inquiries from current students, we estimate at least two or three of our undergraduates per year to enter the program, plus at least three local residents not currently GMU students. The other entering students will be recruited from outside the local area. It is anticipated that we will support five entering students as Teaching Assistants as well as four continuing students per year under research grants and others as part-time employees in local industry or via industry-supported scholarships.

**Note: Target Year** refers to the year the institution anticipates the program will have achieved full enrollment.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Target Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDCT 7</td>
<td>FTES 5</td>
<td>HDCT 15</td>
<td>FTES 10</td>
<td>HDCT 18</td>
</tr>
<tr>
<td>FTES 13</td>
<td>HDCT 20</td>
<td>FTES 15</td>
<td>HDCT 20</td>
<td>FTES 17</td>
</tr>
</tbody>
</table>

**Definitions:** HDCT—fall headcount enrollment, FTES—annual full-time equated student enrollment, GRADS—annual number of graduates of the proposed program

4.9 Resource requirements

The Mathematics doctoral program will require the department to run about two to four additional beginning graduate courses per year, as well as about four additional upper level graduate courses per year. The remaining instruction is delivered via individualized coursework given by faculty on top of their usual course load. The
program has been developed to maximize overlap with courses already taught by other units, to minimize dedicated course scheduling. The additional teaching will be provided by the College of Arts and Sciences through existing faculty lines.

4.9.1 Faculty

There are currently 29 full-time faculty in mathematics. Existing and new faculty members will be expected to develop special topics and elective courses for this program. Part time faculty may be hired to teach in highly specialized areas in which full-time faculty may lack expertise.

4.9.2 Targeted Financial Assistance (Graduate Assistants)

A limited number of full-time students will be supported by teaching and research positions. We have done a careful assessment of available research and teaching assistant positions, current grants, and stipends offered by competitive programs. We consider it feasible for third- and fourth-year students to be supported primarily by grants and pre-doctoral fellowships. However, grants are not appropriate for first- and second-year students, as grants require some mathematical maturity, and those students will be primarily engaged in coursework prior to research. Therefore we plan to support the majority of the first- and second-year students using a combination of internal (unit funded) GRA and GTA positions. We expect the University to provide a pool of funds to support GRA/GTA positions associated with the new program, as is standard practice at GMU. In addition to these internal and external resources, all full-time students will be strongly encouraged to submit proposals to appropriate sources for pre-doctoral fellowship support.

4.9.3 Equipment, Physical Space, and Other Resources

Departmental resources support computational needs and space. Space is a commodity in extremely short supply at George Mason, and the program will require continuing attention to this. A modest budget (funded by GMU) of about $30K, for program expenses, modest equipment purchases not otherwise covered, and dissertation support for the occasional student whose costs are not borne by a grant is requested.

4.9.4 Library

Mathematical journals and books are essential for students. Increasingly, online resources are providing a source of information previously available only in hard copy journals, an option that the library will be encouraged to pursue due to the distributed nature of the GMU campuses. Accordingly, we request a budget of about $15K annually for journals and books. This funding is expected to be provided using central GMU resources, and is a typical level of support for existing doctoral degree programs at the University.
4.9.5 Telecommunications

No additional budget will be required, beyond providing common local phone service for student offices.

4.10 Sources of Funds

Projected Resource Needs for Proposed Program

Part A: Answer the following questions about general budget information.

Has or will the institution submit an addendum budget request to cover one-time costs? Yes_____ No__X__

Has or will the institution submit an addendum budget request to cover operating costs? Yes_____ No__X__

Will there be any operating budget requests for this program that would exceed normal operating budget guidelines (for example, unusual faculty mix, faculty salaries, or resources)? Yes_____ No__X__

Will each type of space for the proposed program be within projected guidelines? Yes__X__ No_____

Will a capital outlay request in support of this program be forthcoming? Yes_____ No__X__
**Part B: Fill in the number of FTE positions needed for the program.**

<table>
<thead>
<tr>
<th></th>
<th>Program initiation year</th>
<th>Total expected by target enrollment year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On-going and reallocated</td>
<td>Added (New)</td>
</tr>
<tr>
<td>Full-time faculty</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Part-time faculty</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Graduate assistants</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Classified Positions</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>0.0</strong></td>
<td><strong>0.0</strong></td>
</tr>
</tbody>
</table>
Part C: Estimated $ resources to initiate and operate the program.

<table>
<thead>
<tr>
<th></th>
<th>Program initiation year 2004 - 2005</th>
<th>Total expected by enrollment year 2008 - 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part-time faculty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduate assistants</td>
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<td></td>
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<tr>
<td>Classified positions</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Fringe benefits</td>
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<tr>
<td>Total personnel costs</td>
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<td>Targeted financial aid</td>
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<tr>
<td>Equipment</td>
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<td></td>
</tr>
<tr>
<td>Library</td>
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<td>0</td>
</tr>
<tr>
<td>Telecommunication costs</td>
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</tr>
<tr>
<td>Other resource needs</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>21</td>
</tr>
</tbody>
</table>
Part D: Certification Statement(s)

The institution will require additional state funding to initiate and sustain this program.

_____ Yes _______________________________________________

Signature of Chief Academic Officer

_X____ No _______________________________________________

1. Statement of Impact/Other Funding Sources.

None

2. Secondary Certification.

If resources are reallocated from another unit to support this proposal, the institution will not subsequently request additional state funding to restore those resources for their original purpose.

_____ Agree _______________________________________________

Signature of Chief Academic Officer

_____ Disagree _______________________________________________

Signature of Chief Academic Officer
Appendix 1 – Supporting letters

Appended are letters from:

Dr. Vernon Smith, Professor of Economics and Law, Interdisciplinary Center for Economic Science, GMU

Dr. Steven Schiff, Krasnow Professor and Professor of Psychology, GMU

Dr. Helena Wisniewski, President, Aurora Biosecurity Solutions Division and Chair, Industrial Advisory Committee for GMU Math

Dr. John Burns, Hatcher Professor of Mathematics and Director of the Center for Optimal Control and Design, Virginia Tech
Letter from Dr. Vernon Smith goes here.
To whom it may concern:

It is with great pleasure that I can write this letter strongly supporting the creation of a PhD program in Mathematics at George Mason University.

I have been at George Mason for 6 years, and in part, my decision to move here with my research group was based on the strong quality of the Mathematics department.

The GMU Mathematics department is World class. I have published now 14 scientific papers with Professor Tim Sauer, a world renown expert on dynamical systems. These works have ranged from theoretical issues related to detecting synchronization and patterns in neuronal activity, to applying such theory to actual experiments and human data ranging from muscle control to Epilepsy. I have more recently worked with Professor Evelyn Sander at GMU, publishing a paper on the structure of synchronization, and I am a Co-Investigator on her new NIH grant, where we will help her apply her considerable expertise to problems in pattern formation in Epileptic seizures.

I have further had the privilege of taking 4 of the GMU graduate level courses in Mathematics in order to help my own background – in Real Analysis, Probability Theory, Dynamical Systems, and Stochastic Differential Equations. I have thus had intimate contact with the quality of this department’s graduate teaching, and have met many of the potential students who would form the pool from which PhD candidates would be drawn. I thus am in a good position to state that the students of the Commonwealth of Virginia would be very well served by being able to pursue PhD degrees with this outstanding faculty.

The importance of Mathematics is skyrocketing for many fields – but none more so than the biological sciences. Ecosystems, genetics, proteomics, molecular folding, infectious disease epidemics, cardiac arrhythmias, and of course, understanding the computation of the brain. In my own work, I seek to understand the underpinnings of how the brain creates epileptic seizures, and how to control them – we will achieve this deeper understanding through our Mathematics.

I can envision that doctoral candidates in Mathematics can also benefit from our laboratory and the Krasnow Institute. We provide a rich experimental setting where a theorist can test out theories in relevant experiments, with people who understand enough mathematics to collaborate at a deep level. The prospects for students to develop and apply their ideas in very unique ways can be offered to PhD candidates at GMU.

Such a program would be a jewel for George Mason and the Commonwealth of Virginia.

With my strongest support and best regards,
Letter from Dr. Helena Wisniewski goes here.
Letter from Dr. John Burns goes here.
Appendix 2

Sample Curriculum 1

Student interested in analysis from the beginning

* indicates a core course (required by all students)

Year 1 - Fall
Math 631: Topology I*
Math 675: Linear Analysis I* [Major]
Math 772: Wavelet Theory [Major]
Math 795: Graduate Seminar

Year 1 - Spring
Math 621: Algebra I*
Math 661: Complex Analysis I [Major]
Math 776: Linear Analysis II [Major]
Math 795: Graduate Seminar

Year 2 – Fall
Math 762: Complex Analysis II [Major]
Math 677: Ordinary Differential Equations* [Minor]
Math 790: Potential Theory [Major]
Math 795: Graduate Seminar

Year 2 - Spring
Math 671: Fourier Analysis [Major]
Math 644: Convex and Discrete Geometry
Math 673: Dynamical Systems [Minor]
Math 795: Graduate Seminar

Preliminary exam: End of summer after second year

Year 3 – Fall
Math 678: Partial Differential Equations [Minor]
Reading Course with Prof. Walnut
Reading Course with Prof. Colonna
Math 795: Graduate Seminar

Year 3 – Spring
Math 763: Functions of Sev Complex Var [Major]
Reading Course with Prof. Walnut
Math 795: Graduate Seminar

Oral Qualifying Exam: End of spring during third year.

Major: Analysis (Real and Complex)
Minor: Dynamics and Differential Equations

Years 4-5

Math 998/999: Math Thesis Credits, with Prof. Walnut
Math 795: Graduate Seminar
Sample Curriculum 2

Student interested in algebra, topology, and combinatorics

Student has trouble deciding who to work with

* indicates a core course (required by all students)

<table>
<thead>
<tr>
<th>Year 1- Fall</th>
<th>Year 1 - Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 675: Linear Analysis I*</td>
<td>Math 677: Ordinary Differential Equations*</td>
</tr>
<tr>
<td>Math 795: Graduate Seminar</td>
<td>Math 795: Graduate Seminar</td>
</tr>
</tbody>
</table>

**Preliminary Exam:** End of the summer after first year

<table>
<thead>
<tr>
<th>Year 2 – Fall</th>
<th>Year 2 - Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 795: Graduate Seminar</td>
<td>Math 795: Graduate Seminar</td>
</tr>
</tbody>
</table>

**Oral Qualifying Exam:** End of the summer after second year

**Major area:** Differential topology and convex geometry

**Minor area:** algebra and combinatorics

<table>
<thead>
<tr>
<th>Year 3 – Fall</th>
<th>Year 3 – Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 611: Recursive Function Theory</td>
<td>Math 661: Complex Analysis</td>
</tr>
<tr>
<td>Math 678: Partial Differential Equations</td>
<td>Math 612: Mathematical Logic</td>
</tr>
<tr>
<td>Reading Course with Prof. Soltan</td>
<td>Reading Course with Prof. Agnarsson</td>
</tr>
<tr>
<td>Math 795: Graduate Seminar</td>
<td>Math 795: Graduate Seminar</td>
</tr>
</tbody>
</table>

**Years 4-5**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Math 998/999: Math Thesis Credits, with Prof. Agnarsson</td>
<td>Math 795: Graduate Seminar</td>
</tr>
</tbody>
</table>
**Student interested in dynamics and topology**

* indicates a core course (required by all students)

<table>
<thead>
<tr>
<th>Year 1 - Fall</th>
<th>Year 1 - Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 675: Linear Analysis I*</td>
<td>Math 673: Dynamical Systems [Major]</td>
</tr>
<tr>
<td>Math 795: Graduate Seminar</td>
<td>Math 795: Graduate Seminar</td>
</tr>
</tbody>
</table>

**Preliminary Exam:** End of the summer after first year

<table>
<thead>
<tr>
<th>Year 2 – Fall</th>
<th>Year 2 - Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 795: Graduate Seminar</td>
<td>Math 795: Graduate Seminar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 3 – Fall</th>
<th>Year 3 – Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 786: Numerical Solutions to Diff Eq</td>
<td>Math 762: Complex Analysis II</td>
</tr>
<tr>
<td>Reading Course with Prof. Wanner</td>
<td>Reading Course with Prof. Wanner</td>
</tr>
<tr>
<td>Reading Course with Prof. Sander</td>
<td>Reading Course with Prof. Sander</td>
</tr>
<tr>
<td>Math 795: Graduate Seminar</td>
<td>Math 795: Graduate Seminar</td>
</tr>
</tbody>
</table>

**Oral Qualifying Exam:** End of the third year

**Major area:** Dynamics and Differential Equations

**Minor area:** Topology

**Years 4-5**

Math 998/999: Math Thesis Credits, with Prof. Sander
Math 795: Graduate Seminar
Sample Curriculum 4

Student interested in topology and algebra

* indicates a core course (required by all students)

Year 1 - Fall

Math 631: Topology I* [Major]
Math 675: Linear Analysis I*
Math 677: Ordinary Diff Equations*
Math 795: Graduate Seminar

Year 1 - Spring

Math 621: Algebra I* [Minor]
Math 673: Dynamical Systems
Math 661: Complex Analysis
Math 795: Graduate Seminar

Preliminary Exam: End of the summer after first year

Year 2 – Fall

Math 722: Algebraic Topology [Major]
Math 678: Partial Differential Equations
Math 724: Commutative Algebra [Minor]
Math 795: Graduate Seminar

Year 2 – Spring

Math 671: Fourier Analysis
Math 732: Topology II [Major]
Math 685: Numerical Analysis
Math 795: Graduate Seminar

Year 3 – Fall

Math 641: Combinatorics and Graph Theory
Math 739: Topics in Diff Top and Geo [Major]
Math 795: Graduate Seminar

Year 3 – Spring

Math 644: Convex Geometry
Math 762: Complex Analysis II
Math 795: Graduate Seminar

Oral Qualifying Exam: End of the third year

Major area: Topology
Minor area: Algebra

Years 4-5

Math 998/999: Math Thesis Credits, with Prof. Kulesza
Math 795: Graduate Seminar
Frequency and Schedule of Graduate Course Offerings

The following schedule is a rough approximation of the frequency of graduate course offerings, provided sufficient funding. Each course is subject to sufficient enrollment (the definition of which may depend on the course and the students enrolled). Entries such as “677/678” indicate that each of these courses will be offered once every two years, on alternate years.

<table>
<thead>
<tr>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>675 [core]</td>
<td>621 [core]</td>
</tr>
<tr>
<td>631 [core]/(*/2)</td>
<td>677 [core]/(*/2)</td>
</tr>
<tr>
<td>673/678</td>
<td>723*/763*</td>
</tr>
<tr>
<td>762*/772</td>
<td>661/671</td>
</tr>
<tr>
<td>641/724*</td>
<td>674/?</td>
</tr>
<tr>
<td>739*/722*</td>
<td>632*/644*</td>
</tr>
<tr>
<td>786/787*</td>
<td>776/784*</td>
</tr>
<tr>
<td>685</td>
<td>685</td>
</tr>
<tr>
<td>781*/790*</td>
<td>725</td>
</tr>
<tr>
<td>(611/613)</td>
<td>(612/614)</td>
</tr>
<tr>
<td>795*</td>
<td>795*</td>
</tr>
<tr>
<td>(998)</td>
<td>(998)</td>
</tr>
<tr>
<td>(999)</td>
<td>(999)</td>
</tr>
<tr>
<td>Topics Courses</td>
<td>Topics Courses</td>
</tr>
<tr>
<td>Reading Courses</td>
<td>Reading Courses</td>
</tr>
<tr>
<td>OR Courses</td>
<td>OR Courses</td>
</tr>
<tr>
<td>CSI Courses</td>
<td>CSI Courses</td>
</tr>
</tbody>
</table>

**Key**
* indicates a new or previously infrequent offering

*/2 indicates that a course was previously offered only 1/2 the frequency it will now be offered

(.) a course that does not require additional recourses to be offered
Graduate Course List

[Math 611: Recursive Function Theory]
[Math 612: Mathematical Logic]
[Math 613: Recursively Enumerable Languages]
[Math 614: Mathematical Models of Computation]
Math 619: Topics in Logic and Computation
Math 621: Algebra
Math 631: Topology I: Topology of Metric Spaces
Math 641: Combinatorics and Graph Theory
Math 644: Geometry and Convexity
Math 661: Complex Analysis
Math 671: Fourier Analysis
Math 674: Stochastic Differential Equations
Math 675: Linear Analysis
Math 677: Ordinary Differential Equations
Math 678: Partial Differential Equations
Math 680: Industrial Math
Math 683: Modern Optimization Theory
Math 685: Numerical Analysis
Math 689: Dynamical Systems
Math 722: Algebraic Topology
Math 723: Combinatorial Structures
Math 724: Commutative Algebra
Math 725: Numerical Linear Algebra
Math 732: Topology II: Set Theoretic Topology
Math 739: Topics in Differential Geometry and Topology
Math 762: Complex Analysis II
Math 763: Functions of Several Complex Variables
Math 772: Wavelet Theory
Math 776: Linear Analysis II
Math 781: Advanced Methods in Applied Math
Math 784: Nonlinear Functional Analysis
Math 786: Numerical Solutions to Differential Equations
Math 787: Variational Methods
Math 790: Potential Theory
Math 795: Graduate Seminar (1 credit)
Math 889: Topics in Applied Math
Math 829: Topics in Algebra
Math 879: Topics in Analysis
Math 998/999: PhD Thesis Credits
Appendix 3: Mathematical Sciences Faculty: brief bio-sketches

Geir Agnarsson received the PhD degree in pure mathematics from the University of California at Berkeley in 1996, under the supervision of George M. Bergman. Since then he has held positions at University of Iceland, Armstrong Atlantic State University, and George Mason University where he joined the faculty as an assistant professor in 2002. He has been a visiting faculty at the University of California at Berkeley, Arizona State University and at Los Alamos National Laboratory. His research interests include algebra, combinatorics and graph theory, in particular graph coloring and coloring algorithms. Currently he is writing a book on graph theory and graph algorithms, which should be published in 2004. He is a member of AMS and an associate fellow of the ICA.

Kathleen Alligood received the PhD in Mathematics from the University of Maryland in 1979. She currently holds the rank of Professor at George Mason University. Her research interests are in the area of dynamical systems and chaos theory. She has coauthored (with T. Sauer and J. Yorke) the book Chaos: An Introduction to Dynamical Systems published by Springer-Verlag in 1997. Her recent publications include (with E. Sander and J. Yorke) Explosions: global bifurcations at heteroclinic tangencies in Ergodic Theory and Dynamical Systems (2002).

Daniel Anderson received the PhD in Applied Mathematics from Northwestern University in 1993. He has since held a postdoctoral position in the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge and a National Research Council postdoctoral research position at the National Institute of Standards and Technology. He was a Research Assistant Professor in the Mathematics Department of the University of North Carolina at Chapel Hill, and has been at George Mason University since 1999, where he currently holds the rank of Assistant Professor. He is currently a guest researcher at the National Institute of Standards and Technology. His research interests include the development of mathematical modeling and scientific computing techniques to study problems arising in fluid mechanics and materials science. Particularly applications include those where hydrodynamics are coupled to phase transformation processes. His research has been supported by federal and industrial grants.

Flavia Colonna received the PhD in mathematics from the University of Maryland (College Park) in 1985. She held a junior faculty position at the University of Bari until she joined the faculty of George Mason University in 1986, where she currently holds the rank of Professor. Her research interests include discrete harmonic analysis, integral geometry, potential theory, and classical complex function theory. Recent publications include (with G. Easley) Geometric transforms and their applications to SAR speckle reduction in Proceedings SPIE 2003, Algorithms for Synthetic Aperture Radar Imagery X (2003), (with Easley) Invariant object recognition based on the generalized discrete Radon transforms in, Proceedings SPIE 2004, Independent Component Analyses, Wavelets, Unsupervised Smart Sensors, and Neural Networks, to appear in 2004, (with J. Cohen and D. Singman) Distributions and Measures on the boundary of a tree in the Journal of Mathematical Analysis and Applications (to appear in 2004) and (with I. Bajunaid, Cohen and Singman) Trees as Brelot spaces in Advances in Applied Mathematics (2003).

Klaus Fischer received the PhD in Mathematics from Northwestern University in 1973 and after a postdoctoral position there, joined the faculty at George Mason University, where he currently holds the rank of Professor. He has held a visiting position at Illinois Wesleyan University and was a visiting scholar at the University of Illinois in Urbana, Illinois. Recently he was the director of the Center for the Applications of Mathematics, which coordinated projects and grants in support of teachers of mathematics. He is currently the Undergraduate Coordinator of the department. His research is in combinatorial and commutative algebra and his most recent work is a series of papers on Mixed Dominating Matrices with J. Shapiro and W. Morris.

Michael Gabel received the PhD in Mathematics from Brandeis University in 1972. He currently holds the rank of Associate Professor at George Mason University. His research interests include commutative algebra and applications of technology to teaching.

Rebecca Goldin received the PhD in Mathematics from the Massachusetts Institute of Technology in 1999. She was a National Science Foundation postdoctoral fellow at the University of Maryland before joining the faculty at George Mason University in 2001, where she currently holds the rank of Assistant Professor. Her research interests include symplectic geometry, Hamiltonian group actions, equivariant cohomology, and combinatorics, and her recent publications include (with T. Holm and L. Jeffreys) Distinguishing the chambers of the moment polytope to appear in the Journal of Symplectic Geometry, (with A.-L. Mare) Cohomology of symplectic reductions of generic coadjoint orbits to appear in Proceedings of the American Mathematical Society, and (with Holm) Real loci of symplectic reductions to appear in Transactions of the American Mathematical Society. She is currently supported by a grant from the National Science Foundation.

Tom Kiley received the PhD in Mathematics from Brown University in 1969. He currently holds the rank of Associate Professor at George Mason University. His research interest is complex analysis.

John Kulesza received the PhD in Mathematics from SUNY Binghampton in 1987. He currently holds the rank of Professor at George Mason University. His research is in the area of general topology. Recent publications include (with J. Schweig) Rim-finite, arc-free subsets of the plane in Topology Applications (2002).
Harbir Lamba received the PhD in Mathematics from the University of Bristol in 1994. He has held postdoctoral positions at the University of Strathclyde, UK, and at Stanford University as well as a visiting researcher position at the Fields Institute for Research in the Mathematical Sciences, Toronto, Canada. He currently holds the rank of Assistant Professor at George Mason University. His main research interests are in nonsmooth dynamical systems, the numerical solution of differential equations and financial mathematics. Recent publications include An adaptive timestepping algorithm for stochastic differential equations to appear in the Journal of Computational and Applied Mathematics. He is currently supervising two PhD students in Computational Mathematics with whom he has published research articles.

James F. Lawrence received the PhD in Mathematics from the University of Washington in 1975. He was an NRC-NBS Postdoctoral Research Fellow at the Operations Research Division of the National Bureau of Standards (now the National Institute of Standards and Technology), and held faculty positions at the University of Texas at Austin, the University of Kentucky, and the University of Massachusetts in Boston. He joined the faculty at George Mason University in 1983 and currently holds the rank of Professor. He also serves as a Faculty Appointee at NIST's Mathematical and Computational Sciences Division, where he works on a part-time basis with NIST staff in studying problems which arise in Discrete Optimization and Computational Geometry. His research interests include Convexity and Combinatorics. He is one of the founders of the theory of Oriented Matroids and is responsible for the Topological Representation Theorem for Oriented Matroids. He has contributed important results to the theory of polytope volume computation, to linear programming, and to the combinatorial theory of polytopes more generally.

L. Brian Lawrence received the PhD in Mathematics from SUNY Binghampton in 1984. He currently holds the rank of Professor at George Mason University. His research is in set theoretic topology and he has recently published (with J. Shapiro) Rings of quotients of rings of functions to appear in Topology and its Applications.

Ronald Levy received the PhD in Mathematics from Washington University in 1974. He currently holds the rank of Professor at George Mason University. His research is in set theoretic topology and logic and computation. Recent publications include A rigid subspace of the real line whose square is a homogeneous subspace of the plane to appear in the Transactions of the American Mathematical Society (1994).

Teck-Cheong Lim received the PhD in Mathematics from Dalhousie University, Canada, in 1974. He held an instructor position at The University of Chicago in 1975 and joined the faculty of George Mason University in 1979, where he currently holds the rank of Associate Professor. His research interests include functional analysis, geometry of Banach spaces, linear algebra and number theory. Some of his recent publications include Fixed point sets of isometries on weakly compact convex sets in the Journal of Mathematical Analysis and Applications (2003) and On characterizations of Meir-Keeler contractive maps in Nonlinear Analysis (2001).

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