Departmental Self-Study
By
The Department of Mathematics
University of South Carolina, Columbia

November 2002

Findings of the Previous Review

The Department of Mathematics at the University of South Carolina was last reviewed by an external committee in 1985. The committee was composed of Dr. W. F. Ames (Georgia Institute of Technology), Dr. P. Griffith (University of Illinois at Urbana-Champaign), Dr. J. Mycielski (University of Colorado), Dr. J. Spencer (SUNY at Stony Brook), and Dr. J. J. Uhl, Jr. (University of Illinois at Urbana-Champaign) who chaired the committee. The external review committee found that the Department had a strong base to become a quality research department, but that there was a major problem with the salary levels. Many specific recommendations were also given, which included:

- Salaries need to be made competitive.
- A senior visitor program should be established.
- Better computing facilities are needed.
- The Department should recruit two senior numerical analysts and three additional applied mathematicians should be hired.
- The Department should put more effort into recruiting graduate students regionally and graduate fellowships are needed.
- The scheduled renovation of LeConte can come none too soon.

The full report from the external review committee is attached in Appendix IX.

Progress

In the period since the last review, the quality of the faculty has continued to improve. Among the current faculty are strong research mathematicians in approximation theory, commutative algebra, complex analysis, differential geometry, discrete mathematics, functional analysis, harmonic analysis, logic, number theory, numerical analysis, partial differential equations and topology. This period saw significant growth in the Department's strength in differntial geometry, functional analysis and number theory. But the greatest effort, following the recommendations of the 1985 external evaluators, was invested in strengthening the Department in applied mathematics. The approximation theory/harmonic analysis group has in particular developed into an internationally renowned research group. Based on data collected by the National Research Council, the Department had the fourth highest rating nationwide for improvement over the period 1988-1993.

The improvement in research productivity during this period is reflected by the increase of external research funding. According to data published by the National Science Foundation, the federal funding to the mathematical sciences in the University of South Carolina is ranked 24th (1997), 25th (1998), 35th (1999) and 29th (2000). The same data show that the University of South Carolina has been ranked in the top ten nationally in every fiscal year since 1994 in terms of the amount of funding from all sources for mathematical research. (In fiscal year 2000, the University of South Carolina was ranked number six in the country.)

Some of the faculty members hired in this period were recruited under a major EPSCoR Grant "Industrial Mathematics Initiative" (1992–1995) to the Department. In 1999, the Industrial Mathematics Institute (IMI) was formed with Dr. Ronald DeVore as Director. Its mission is to foster research in areas with capacity or potential for industrial applications and to facilitate the transfer of these results between academic and industrial sectors. Through grant overhead funds, the IMI has developed a Distinguished Lecture Series, a postdoc and visitor program, and a preprint series.

The Mathematics Department has received internal funding and numerous external grants to improve its computing facilities. It now has one SUN Enterprise 450 server with 512 MB of RAM, a SUN Blade 100 (the Department web server) and two pentium III 1 Ghz NT servers. Each faculty member has either a SUN Ultra 10, SUN Ultra 5, Pentium 4 PC or a Power MAC G4 machine in his/her office, and most also have a HP, Lexmark or Apple laser printer. There is also a computer in each graduate student office. The IMI has additional facilities which include a multiprocessor Beowulf system, a FakeSpace Systems PowerWall and two stereo monitors, a SUN Fire 280R server and several Silicon Graphics machines.

The Mathematics Library, located in the Department, has grown into a fair sized research library with more than 18,000 volumes of books and periodicals and current issues of more than 200 mathematics journals.

Faculty and graduate students can also access journals electronically from their offices through online subscriptions, ScienceDirect, JSTOR and InfoTrac Web. Arrangements can also be made to access the material from off campus through a proxy server.

Challenges

Seventeen years after the last review, while the Department has made substantial progress on two of the 1985 recommendations, it still faces many of the same difficulties. Moreover, because the size of the Department was not increased, this period also saw losses in discrete mathematics, logic, and algebra. Faculty salaries and graduate stipends are still not competitive and there are still too few faculty members. The physical facilities are in dire need of repair. (The scheduled renovation mentioned in the 1985 report never came to pass). Furthermore, recent budget cuts have dramatically reduced the support for colloquia, faculty travel and library resources.

Indeed, the current state of the Department's budget respresents of particularly acute challenge. During the 2001–02 fiscal year the Department was forced to absorb a permanent budget cut of approximately $140,000. This cut was partially met by the salary savings from one faculty position. The remainder of the cuts came from the funds used to hire undergraduate graders, math lab assistants, and part-time graders. During the current academic year, 98% of the total Department budget is for faculty, staff, and graduate assistant salaries. The remaining 2%, approximately $66,000, is used for non-personnel expenditures: supplies, Xeroxing, annual dues, etc. In 2001–02, non-personnel expenditures were about $91,000. At this time there are absolutely no funds in the Department budget to hire graders, math lab assistants, or part-time instructors. During the 2002–03 academic year, this is being accomplished through salary savings and one-time funds from the Dean's and Provost's office. The graduate student budget is also severely underfunded. In 1994 the Department supported 46 graduate assistants in mathematics. With the continued increase in stipends, and stagnant or declining budgets, by Fall 2002 the number of graduate assistants has declined to 34. These problems have to be addressed. The Department budget needs to be increased to provide adequate funding for undergraduate assistants, part-time instructors, and to support a viable graduate program. The graduate budget also needs to be adjusted annually to provide for increases in graduate assistant stipends.

At the same time, mathematics is becoming increasingly important in other disciplines such as the biosciences, telecommunication, medicine, and finance. Therefore, the Mathematics Department should play an active role in the University's drive to increase its scientific presence in areas such as bioinformatics, biotechnology, nanotechnology, information science, and business. This offers exciting new opportunities for mathematics but also increases the demands on a small department.

The Department of Mathematics at USC is at a crossroads. The faculty, while few in number, is comparable to faculty at the best programs in the Southeast. The Department has aspirations to move its program to a higher level.

The next five years will see the retirement of perhaps as much as a third of the members of the Department. We are faced with the prospect of continual budget cuts, dilapidated infrastructure, depressed salaries, and an indecisive University administration. Nationally mathematics will face a large number of retirements and a smaller than normal infusion of new talent. The Department will therefore be challenged to maintain its current position, much less move to the next level. Competition for hiring will be fierce, and retention and replacement of its current researchers will be a major problem.

The University administration must take decisive action or the years of steady buildup of a quality mathematics faculty will be swept away. At a minimum, the administration must take the following actions.

Recommendations

- **Make Faculty Salaries Competitive:** The current level of faculty salaries is deeply troubling. Recent Ph.D.'s (four years out) from our own program are already commanding salaries comparable to those of some of our full professors. During the 2001–02 academic year, applicants we attempted to hire at the assistant professor level had offers from comparable institutions for $60,000 or higher. Our mean salaries fall, at every rank, by between $5,000 and $10,000 in comparison to our aspirant institutions. To retain the most valuable of our current faculty and to recruit new faculty members, as must be done even to maintain the program at something close to it current level, requires immediate action on this point.

• **Increase the Size of the Faculty:** Nationally prominent mathematics departments at public universities the size of ours have active research groups working across a broader range of mathematics, supporting a larger and more diverse doctoral program, and have teaching loads comparable to those of our colleagues in the laboratory sciences. The small size of our faculty is a genuine barrier to moving the Department to the next level. Successful programs at the University of California at San Diego and at SUNY at Stony Brook, to name just two, indicate that a faculty of roughly 50 tenured/tenure-track members, supplemented by half a dozen postdoctoral appointments is needed to mount a first-rate mathematics program at a university of this size. Increasing the faculty size to roughly 50 would bring the Department's student/faculty ratio into line with the University's average. The current tenured/tenure-track faculty of 36 falls too far short. To make progress on this goal, the University administration must adequately fund vacant positions, and add at least five additional positions in the next three years.

• **Institute a Cohesive Plan for Faculty Hiring:** While the University is now faced with continuous budget cuts which challenge its current resources, even in good times the administration has not addressed the loss of personnel in mathematics. The administration must make tough decisions. One of them should be to prevent the collapse of the Department of Mathematics. Inaction here will cost the University far more in the long run. A coherent plan, as well as a firm commitment of funds is needed. At a minimum, the Department must make two senior hires associated to the IMI over the next three years. The retirement of Ronald DeVore in the near future will deplete the IMI of its senior leadership. Five new junior positions are also needed over over the next three years. These new positions should be filled to address the Department's need for balanced strength in core areas of mathematics and to enable the Department to expand into areas of national need. Those current positions which become vacant (and we anticipate 12) must be filled in way that retains or enhances our current areas of strength. It is essential that open positions be filled with gifted mathematicians. Finally, external funding should be sought to establish a research group in biomathematics.

• **Address the Dilapidated Conditions of LeConte:** Some faculty can remember being recruited 25-30 years ago with the promise of renovation of LeConte. Not only has this not taken place, the general repair of the building has suffered in the meantime. LeConte is over 50 years old. There has been little investment to improve its infrastructure. It is a depressing environment which is a real impediment to recruiting and to maintaining faculty spirit. Quite frankly, over a period of 30 years, the upper administration of the University has simply not addressed this problem. A major renovation of the heating/cooling and electrical systems must take place. Restrooms must be renovated. Offices must be renovated and space must be allocated to accommodate seminars and colloquia. Undergraduate access to computers in our building must be expanded. Simply moving the Mathematics Department to another inadequate facility not tailored to the needs of mathematics is no answer.

• **Increase the Number of Chaired Professorships in Mathematics:** This is essential for recruiting senior mathematicians of the highest rank and retaining its most gifted scholars. The Department has only one chaired professorship. The Department has nominated current faculty for chairs with no success. One chair was recently lost with the resignation of Dr. Jawerth. This chair needs to be restored and at a minimum two additional chairs established. This still would not bring the Department into line with the other departments in the College.

• **Institute a Named Postdoctoral Program:** Such programs are a major component of most Group I institutions. They bring recognition to the institution and guarantee an influx of fresh ideas into its research program. At present, all postdoctorals at USC are funded through grants of the IMI or sabbatical replacements. Three permanently funded recurring postdoctoral positions need to be established. The Department will apply for a VIGRE grant which if funded could add to the postdoctoral program.

• **Address the Depletion of Mathematical Resources:** Mathematics is different than other science departments. It puts less of a demand on laboratory space and equipment but has more pressing needs in computational equipment and library resources. The library is our mathematics research lab and must be treated as such. Steps must be taken to recover the recent losses of research journals and add others that are crucial to support the growth of the faculty and the graduate program. The Department has been successful at acquiring computational facilities through grants. But there is no program in place to maintain these acquisitions. Permanent funding must be appropriated for maintenance and repair of computer equipment.

- **Increase Funding of the Department's Travel and Colloquium Budget:** The travel and colloquium budgets are woefully inadequate. The current budget allows $14,500 for faculty travel. Even with restrictions placed on the reimbursed for airfare and no funding for meals, the expenditures in 2001–02 was approximately $25,500. This total does not include travel funded by grants. To fully support faculty travel this budget category should be increased to a minimum of $30,000 per year. The colloquium budget stands at a pitiful $4,000 per year.This enables the Department to bring in 2–3 prominent researchers per semester. To sustain a viable colloquium series the funding must be increased to $15,000 per year. (Twenty years ago our colloquium budget was $10,000, enough at the time to bring in 20 distinguished mathematicians.) Part of this funding should be used to establish a Distinguished Lecture Series. Such a series already exists in the IMI funded entirely through grants. The Distinguished Lecture Series would bring outstanding research lecturer to campus for an extended series of lectures.

- **Establish a Center for Scientific Computation:** Computational science is a large component of research at USC spreading over the College of Engineering and Information Science,and the College of Science and Mathematics. Every science has an experimental and computational component. The nation faces critical needs in large scale modelling and their numerical treatment in such areas as groundwater modelling, atmospheric modelling, fluid mechanics, solid mechanics, inverse engineering, computer aided design, nanoscience, and biomathematics. Those universities able to address these problems will garner a large portion of future research funding. The IMI offers a core in scientific computation around which to build such a center. However, the Center would most naturally live outside of the Department and perhaps even outside any of the Colleges.

- **Increase the Number and Size of Graduate Stipends:** Over the next five years the enrollment in the graduate program should double and be centered more securely in the Ph.D. program. This change is necessary to provide a more vibrant research environment needed to attract first-rate faculty and graduate students and to support a richer course offering. Stipends must be increased to compete with other institutions. The University has been trying to address the problem of insufficient stipends. But the situation is changing very fast nationally in the direction of increased stipends because of the decrease of students in the sciences. Thus, this problem will need continual attention.

- **Enhance the Undergraduate Program:** Over the next five years the number of majors should double and class sizes in the calculus sequence should contract, as proposed elsewhere in this document. The Department should undertake a variety of activities within the University and the state to attract more and stronger majors.

Comparison of Mathematics Departments

We have selected the following universities as our peer/aspirant group:

Georgia Institute of Technology
Indiana University
Michigan State University
North Carolina State University
SUNY at Stony Brook
University of California, San Diego
University of Georgia
University of North Carolina
University of Virginia
University of Washington

All of these are public universities with missions similar to that of the University of South Carolina. These universities have mathematics programs that have strong reputations, with eight of these ten being Group I institutions according to the rankings of the American Mathematical Society. The University of California at San Diego is the most highly rated of these. North Carolina State and Georgia Tech have exhibited a rapid rise in the rankings conducted for the National Research Council. Comparing total undergraduate enrollment, Indiana University and Michigan State are twice as large as the University of South Carolina, while UCSD, SUNY Stony Brook, University of North Carolina, and the University of Virginia are roughly the same size. Apart from undergraduate enrollment, there are other points to consider in this comparison. The University of North Carolina has no engineering program (decreasing the relative demand for service courses) while Georgia Tech has a higher percentage of students pursuing degrees in science and engineering (increasing the relative demand for service courses).

While this comparison group favors universities in the Southeast (which share many of the demographic attributes and budgetary constraints of our University), the group also includes institutions from all regions of the country.

Comparison of Faculty and Student Profiles*

	USC	GaTech	IUB	MSU	NCSU	SUNYSB	UCSD	UGA	UNC	UVA	UWA
Faculty Size											
Tenure-track	36	67	51	72	67	49	51	39	37	35	67
Instructors	2	4	0	9	8	4	2	17	2	0	0
Post Docs	2	0	6	0	3	15	6	10	0	5	3
University Enrollment											
Undergraduate	15,266	10,256	30,153	34,342	21,990	13,646	16,494	23,772	15,355	12,598	24,987
Graduate	8.462	3,818	7,806	9,024	6,335	7,209	3,680	7,079	8,689	6,250	10,152
Mathematics Graduate Program (2000–2001)											
Full-time Enrollment	43	61	106	124	113	68	81	41	52	41	84
Masters degrees	4	8	13	22	17	15	5	0	6	4	13
Ph.D.'s (1998–01)	14	20	25	27	27	28	35	15	15	16	21
Mathematics Undergraduate Program (2000–2001)											
Enrollment	155	142	n.a.	480	210	n.a.	285	114	n.a	n.a.	245
Bachelors degrees	28	16	31	39	35	39	85	28	93	40	114
Mathematical Research Publications											
1983–1987 Total	302	287	443	369	308	286	460	233	274	219	416
Advanced Books	3	0	6	3	2	4	10	4	8	3	14
1988–1992 Total	216	320	421	347	313	339	502	192	243	263	452
Advanced Books	2	12	13	12	7	10	15	4	9	8	14
1993–1997 Total	209	317	450	431	314	254	419	247	255	181	396
Advanced Books	5	7	16	6	6	4	6	5	16	5	16
1998–2002 Total	194	298	354	304	271	154	326	225	189	188	342
Advanced Books	1	2	8	11	7	3	17	4	0	4	11
1983–2002 Total	921	1222	1768	1481	1206	1033	1707	907	961	851	1606
Advanced Books	11	21	43	32	22	21	48	17	33	25	55
External Research Funding (Dollars in Thousands for Fiscal 2000)											
All Sources	9,911	5,829	2,077	876	10,839	4,903	1,078	4,732	797	n.a.	4.366
National Rank	6	10	44	83	5	17	70	18	90	n.a.	20
Federal Sources	2,108	2,415	1,033	599	4,494	3,006	894	598	719	n.a.	3,849

*) See the note at the end of this section for data sources

With respect to the level of mathematical research activity represented by the publication data, the University of South Carolina is comparable with the University of Georgia, the University of North Carolina, and the University of Virginia—the institutions it most resembles in terms of enrollment, faculty size, and graduate student population. However, it should be noted that the number of advanced mathematics books published at the University of South Carolina is noticeably smaller than at the cohort of the other three universities. SUNY at Stony Brook seems to be a little more active at publishing. The University of California at San Diego represents the highest level of activity in publishing. The higher levels at the remaining institutions might be accounted for by significantly larger faculties and significantly larger populations of graduate students—providing not only a larger pool of authors, but perhaps also greater stimulation due to a larger range of interactions.

With respect to external funding, the University of South Carolina compares very favorably. During the period 1996–2000 the University of South Carolina consistently ranked in the top ten in total external funding for research in the mathematical sciences (including in statistics), according to "Academic Research and Development Expenditures", a report published annually by the National Science Foundation.

With respect to undergraduate programs, at the University of South Carolina a little more than 1% of the baccalaureate degrees each year are in mathematics. This appears to be comparable to the level at most of our comparison group (and noticeably higher than at the University of Georgia or at Georgia Tech). The University of North Carolina is strikingly successful at attracting and graduating mathematics majors—roughly 3% of the baccalaureate degrees at Chapel Hill go to mathematics majors.

With respect to graduate programs, the University of South Carolina is comparable with the University of Georgia, the University of North Carolina, and the University of Virginia. The University of California at San Diego and SUNY at Stony Brook, which are institutions of about the same size, have evidently much larger and more productive programs.

Faculty salaries offers another point of comparison that will take on increasing significance over the next five years as the University enters a period of increased activity in hiring new faculty and retaining current faculty. The table below provides current comparative salary data.

Comparison of 2001-2002 Mean Salaries with Peer and Aspirant Institutions

Group	Assistant Professor	Associate Professor	Professor
Group I (Public)	\$55,600	\$65,461	\$96,380
Group II	\$51,701	\$59,220	\$82,274
Comparison Group	\$54,271	\$61,080	\$86,277
University of South Carolina	\$46,409	\$55,035	\$75,340
Difference with Comparison Group	\$7,862	\$6,045	\$10,937

This information was prepared for us by the American Mathematical Society based on their "Faculty Salaries Survey of the 2001 Annual Survey of the Mathematical Sciences".

Group I (Public) consists of the 25 most highly rated mathematics departments at public universities, Group II consists of 56 matheamtics departments with the next highest group of ratings. The University of South Carolina belongs to Group II. The Comparison Group consists of the following universities:

Georgia Institute of Technology	Indiana University	Michigan State University
SUNY at Stony Brook	University of Georgia	University of South Carolina
University of Virginia	University of Washington	

North Carolina State University, the University of North Carolina, and the University of California, San Diego did not submit data to the American Mathematical Society.

With respect to faculty salaries, the University of South Carolina is not even close to being competitive.

Sources of Data

The data on enrollments and faculty size was gathered from websites maintained by the various institutions. Enrollment by major was not available from Indiana University nor from SUNY Stony Brook. The enrollments figure for mathematics majors at the University of North Carolina is, apparently, for upper division students.

The data on the number of degrees at each level was reported by each institution to the American Mathematical Society and published by the Society in "2000 Assistantships and Graduate Fellowships in the Mathematical Sciences". For bachelor's and master's degrees the number awarded in 1999-00 is reported. For Ph.D.'s the number over the period 1997–00 is reported.

The data concerning publications was gathered from the American Mathematical Society's MathSciNet webpage. It reflects publications reviewed by Mathematical Reviews beginning in 1983, when Mathematical

Reviews started recording institution codes. Some of these publications are attributable to faculty members in other disciplines and to graduate students, as well as to members of the mathematics faculties at the various institutions.

The dollar figure (in thousands) is the amount of research expenditures from all sources in fiscal 2000, the most recent year for which data is available. These figures are gathered and published every year by the National Science Foundation in its report "Academic Research and Development Expenditures, Fiscal Year 2000". The amounts reported are for research expenditures in the mathematical sciences (which includes statistics as well as mathematics, but not computer science). Only institutions ranking in the top 100 are reported by NSF.

The Mathematics Faculty

A. Profile of the Mathematics Faculty

An Overview of the Faculty

The faculty of the Department consists of 36 tenured or tenure-track members, who teach at both the undergraduate and graduate levels, and two faculty members who hold nontenure-track appointments as senior instructor and lecturer.

Faculty Demographics

	1995–96	1996–97	1997–98	1998–99	1999–00	2000–01	2001–02
Graduate Faculty (Headcount)	35	38	38	38	38	37	36
Graduate Faculty (FTE)	32	35	35	35	35	34	33
Graduate Advisors	6	6	6	6	5	6	6
Master's Supervisors	8	10	9	8	6	7	5
Ph.D. Supervisors	12	12	11	13	12	9	9
Professors	18	20	20	19	21	20	20
Tenured	18	18	18	17	19	19	20
Associate Professors	12	14	16	17	15	15	14
Tenured	12	13	15	16	14	14	14
Assistant Professors	5	4	2	2	2	3	2
Instructors	2	2	2	2	2	2	2
Totals	37	40	40	40	40	39	38

The demographic information gathered in the table above reflects the long term state of the Department: a faculty of 38 tenure-track mathematicians and 2 instructors. At the beginning of the 1995–96 academic year, the faculty experienced four losses: Dr. Jeong Yang, long-time faculty member and Undergraduate Director, died unexpectedly; Dr. Bjorn Dahlberg, winner of the Salem Prize, resigned for health reasons, Dr. James Walker left his tenured position for a job in the software industry, and one faculty member failed to achieve tenure. Over the ensuing years Drs. Scheiblich and Markham retired, each with more than 30 years of service. Six outstanding mathematicians, Drs. Pencho Petrushev, Ognian Trifonov, Laszlo Székely, Kevin Ford, Mohammed Ghomi, and George Androulakis, were hired. At the beginning of the Fall 2000 semester, Dr. Bjorn Jawerth, the David W. Robinson Professor of Mathematics, resigned to devote his full attention to a mathematical consulting firm he had founded. Dr. Ford resigned at the end of the Fall 2001 term to take a tenure-track position at the University of Illinois. These positions are still vacant.

For 12 of the 36 tenure-track/tenured faculty members, at least 30 years have elapsed since they received their Ph.D.'s and began their professional careers. We anticipate that over the next seven or so years as many as one third of our tenured faculty will have to be replaced in an increasingly competitive national market. Already six faculty members have committed to retiring by 31 December 2006 at the latest.

Current Mathematics Faculty

George Androulakis Assistant Professor	Ph.D. 1996 University of Texas at Austin	Functional Analysis
Howard Becker Associate Professor	Ph.D. 1979 University of California, Los Angeles	Logic and Set Theory
Colin Bennett Professor	Ph.D. 1971 University of Newcastle Upon Tyne	Computational and Harmonic Analysis
Susanne Brenner Professor and Assistant Chair	Ph.D. 1988 University of Michigan	Numerical Partial Differential Equations
Ronald DeVore Robert L. Sumwalt Professor Industrial Mathematics Institute Director	Ph.D. 1967 Ohio State University	Analysis and Numerical Computation
Stephen Dilworth Professor	Ph.D. 1985 Cambridge University	Functional Analysis
Daniel Dix Associate Professor	Ph.D. 1988 University of Chicago	Partial Differential Equations
Michael Filaseta Professor	Ph.D. 1984 University of Illinois, Urbana	Number Theory
Mohammed Ghomi Assistant Professor	Ph.D. 1998 Johns Hopkins University	Differential Geometry
Maria Girardi Associate Professor	Ph.D. 1990 University of Illinois, Urbana	Functional Analysis
Jerrold Griggs Professor	Ph.D. 1977 Massachusetts Institute of Technology	Discrete Mathematics
Peter Harley III Associate Professor	Ph.D. 1966 University of Georgia	Topology
Ralph Howard Professor	Ph.D. 1982 California Institute of Technology	Differential Geometry
Richard Hudson Associate Professor	Ph.D. 1971 Duke University	Number Theory
George W. Johnson Associate Professor	Ph.D. 1971 University of Tennessee	Differential Equations and Numerical Optimizaion

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Marek Kossowski Associate Professor	Ph.D. 1982 University of North Carolina, Chapel Hill	Differential Geometry and Partial Differential Equations
Andrew Kustin Professor	Ph.D. 1979 University of Illinois, Urbana	Commutative Algebra
George F. McNulty Professor	Ph.D. 1972 University of California, Berkeley	Varieties of Algebras and Equational Logic
Douglas Meade Associate Professor and Undergraduate Director	Ph.D. 1989 Carnegie Mellon University	Mathematical Modeling and Applied Differential Equations
Matthew Miller Professor	Ph.D. 1979 University of Illinois, Urbana	Commutative Algebra and Mathematical Biology
Peter Nyikos Professor	Ph.D. 1971 Carnegie-Mellon University	Set Theory and Topology
Konstantin Oskolkov Professor	Ph.D. 1972 Steklov Institute	Analysis
Pencho Petrushev Professor	Ph.D. 1977 University of Sofia	Approximation Theory
James W. Roberts Professor	Ph.D. 1971 Rutgers University	Functional Analysis
Anton Schep Professor and Graduate Director	Ph.D. 1977 University of Leiden	Functional Analysis
Robert Sharpley Professor	Ph.D. 1972 University of Texas, Austin	Computational and Harmonic Analysis
Paul Sperry Associate Professor	Ph.D. 1963 New Mexico State University	Abelian Groups
Robert Stephenson Professor	Ph.D. 1967 Tulane University	Topology
Manfred Stoll Professor and Department Chair	Ph.D. 1971 Pennsylvania State University	Function Theory; Several Complex Variables

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David Sumner Associate Professor	Ph.D. 1971 University of Massachusetts	Discrete Mathematics
Li-Yeng Sung Associate Professor	Ph.D. 1983 State University of New York, Stony Brook	Partial Differential Equations
Laszlo Szekely Professor	Ph.D. 1983 Eötvös University	Discrete Mathematics
Vladimir Temlyakov Professor	Ph.D 1978 Steklov Institute	Approximation Theory
Ognian Trifonov Associate Professor	Ph.D. 1990 University of Sofia	Number Theory
Hong Wang Associate Professor	Ph.D. 1992 University of Wyoming	Numerical Methods
Xian Wu Associate Professor	Ph.D. 1986 Harvard University	Algebraic Geometry

The following faculty members hold nontenure-track positions:

Robert Murphy Lecturer	B.S. 1989 University of Illinois, Urbana	Mathematics Education
Mary Ellen O'Leary Senior Instructor	M.A. 1967 University of Michigan	Mathematics Education

Mary Ellen O'Leary devotes her primary work to freshman calculus. She has been awarded the USC Freshman Advocacy Award and the USC Educational Foundation USC Outstanding Faculty Award. Robert Murphy, who is also completing his M.S. in Mathematics, is Director of the Mathematics Laboratory, a walk-in help center for lower division mathematics courses, in addition to his teaching.

B. Distinctions of the Faculty of Mathematics

National and International Recognition

The National Research Council: Based on data collected in 1993, the most recent occasion for national evaluation of mathematics research-doctorate programs, the programs of the Mathematics Department were rated as good. Among mathematics programs nationally, it had the fourth highest rating nationwide for improvement over the period 1988–93. The American Mathematical Society has included the Department of Mathematics among its Group II departments.

The National Science Foundation: Ranked the Department of Mathematics **6th** in the nation in terms of total external funding for mathematical research in fiscal 2000, the most recent year for which data are available. The Department has ranked in the top ten since fiscal 1994.

The American Mathematical Society: Ranked the Mathematics Department **10th** in the nation in terms of the percentage of Ph.D. degrees in mathematics awarded to women over the period 1980-1990.

The American Academy of Arts and Sciences: Dr. Ronald DeVore elected to membership (2001).

Royal Dutch Academy of Sciences: Dr. Anton Schep elected as Corresponding Member (1995).

The Hardy-Ramanujan Award: Dr. Michael Filaseta and Dr. Ognian Trifonov (1991).

Best Paper Award, Journal of Complexity: Dr. Ronald DeVore and Dr. Vladimir Temlyakov for their paper, "Nonlinear approximation in finite dimensional vector spaces." (1997)

Premium for Mathematical Research, Soviet Academy of Science: Dr. Vladimir Temlyakov (1990).

Silver Medal, Exhibition of National Economic Achievement, USSR: Dr. Vladimir Temlyakov (1989).

Outstanding Publication Award, Soviet Academy of Science: Drs. Vladimir Temlyakov (1989) and Konstantin Oskolkov (1990).

Outstanding Publication Award, Steklov Institute: Drs. Konstantin Oskolkov (1978, 1982, 1988) and Vladimir Temlyakov (1979, 1982, 1986, 1998).

Outstanding Publication Award, Department of Mathematics, Steklov Institute: Dr. Konstantin Oskolkov (1970, 1972, 1975, 1977, 1984, 1986).

"N. Obreshkov" Bulgarian National Mathematics Award: Dr. Pencho Petrushev (1986).

Invited Hour Speakers, American Mathematical Society: Drs. Ronald DeVore (1990), George McNulty (1994), Vladimir Temlyakov (2000), and Susanne Brenner (2001).

SIAM Invited Address: Dr. Ronald DeVore (1992, 2000).

Canadian Mathematical Society Invited Address: Drs. Colin Bennett (1979), Ronald DeVore (1994).

Alexander von Humboldt Fellows: Drs. Ronald DeVore (1976–77, 2002 Senior Fellow), George McNulty (1983), Anton Schep (1987–88), Laszlo Szekely (1991–92), and Maria Girardi (2000–01).

EPSRC Visiting Fellows, Imperial College, London: Drs. Li-Yeng Sung and Susanne Brenner (2001).

SERC Visiting Fellow, Oxford University: Dr. Peter Nyikos (1986).

Fulbright-Hays Professorship: Dr. George McNulty (1982–83).

Ulam Lecturer, University of Colorado: Dr. George McNulty (1998).

Mathematical Sciences Research Institute: Drs. Maria Girardi (Member 1996), Susanne Brenner (Research Professor 2000), and Mohammad Ghomi (Clay Institute Fellow 2000).

NSF Postdoctoral Fellows: Drs. Peter Nyikos (Chicago 1974–75) and Howard Becker (CalTech 1982–84).

NRC (Canada) Postdoctoral Fellow: Dr. George McNulty (1972–73).

South Carolina Recognition

In 1987, the most recent occasion for review of graduate programs in mathematics at public institutions in the state, the South Carolina Commission on Higher Education awarded the Department its **Commendation for Excellence**, citing the high quality of its programs leading to the M.S. and Ph.D. in mathematics.

National and International Presence

Editorial Boards

Advances in Computational Mathematics	Dr. Ronald DeVore	1991–present
Algebra Universalis	Dr. George McNulty	1991–present
American Mathematical Monthly	Dr. Michael Filaseta (Problem Section)	1991–1997
	Dr. Jerrold Griggs (Problem Section)	1992–present
Analysis Mathematica	Dr. Konstantin Oskolkov (Deputy Editor-in-Chief)	1975–present
Approximation Theory and Its Apllications	Dr. Pencho Petrushev	1990–present
Chemical Rubber Co.	Dr. Ronald DeVore (Book Editor)	1994–present
Combinatorica	Dr. Laszlo Szekely	1987–present
Constructive Approximation	Dr. Ronald DeVore (Editor-in-Chief)	1983–present
	Dr. Robert Sharpley	1990–present
	Dr. Vladimir Temlyakov	1994–present
Discrete Mathematics (Special Issue)	Dr. Jerrold Griggs	1999–2000
East Journal of Approximations	Dr. Konstantin Oskolkov	1995–present
	Dr. Pencho Petrushev	1995–present
	Dr. Vladimir Temlyakov	1995–present
Electronic Transactions in Numerical Analysis	Dr. Susanne Brenner	1999–present
Far East Journal of Mathematical Sciences	Dr. Stephen Dilworth	1998–present
Function Spaces	Dr. Stephen Dilworth	2002–present
Integers, The Electronic Journal of Combinatorial Number Theory	Dr. Jerrold Griggs	1999–present
J. Approximation Theory	Dr. Ronald DeVore	1990–present
J. Complexity	Dr. Ronald DeVore	1995–present
J. Foundations of Computational Mathematics	Dr. Ronald DeVore (Advisory Board)	2001–present
J. Symbolic Logic	Dr. Howard Becker	1998–2000
J. Korean Soc. for Industrial and Applied Math.	Dr. Hong Wang	2001–present
MapleTech	Dr. Douglas Meade	1996–1999
Mathematics of Computation	Dr. Susanne Brenner	1993–present
MAA Classroom Resource Materials	Dr. Douglas Meade	2002–2005
Notices of the American Mathematical Society	Dr. Susanne Brenner	2001-present
Numerical Methods for Partial Differential Equations	Dr. Hong Wang	2000–present
Numerische Mathematik	Dr. Ronald DeVore	1991–present
	Dr. Susanne Brenner	1998–present
Pan American Math. J.	Dr. Ronald DeVore	1994–present
SIAM J. Discrete Math.	Dr. Jerrold Griggs	1988–present
	(Editor-in-Chief)	2003–2006
SIAM J. Numerical Analysis	Dr. Ronald DeVore	1980–1992
	Dr. Susanne Brenner	1997–present
Spectrum (Mathematical Association of America)	Dr. Michael Filaseta	2001–present
Topology and Its Applications	Dr. Peter Nyikos	1983–present
Topology Proceedings	Dr. Peter Nyikos (Problems Editor)	1976–1996
Vietnam Mathematical Journal	Dr. Vladimir Temlyakov	1998–present

National Panels

AMS Nominations Committee	Dr. Ronald DeVore	1986–1988
AMS Southeastern Region Program Committee	Dr. Matthew Miller	1993–1995
	Dr. Ronald DeVore	2000–2001 (Chair)
MAA Visiting Speakers Panel	Dr. Jerrold Griggs	1992–1996
NSF Classical Analysis Program Review	Dr. Ronald DeVore	1994
NSF Graduate Fellowship Selection Panel	Dr. George McNulty	1989
	Dr. Jerrold Griggs	1990–1992
NSF Science and Technology Centers Site Review	Dr. Jerrold Griggs	1988
NSF Research Planning Grants and Career Advancement Awards for Women and Minorities Panel	Dr. Susanne Brenner	1997
NSF Group Infrastructure Grants Panel	Dr. Susanne Brenner	1997
NSF-CBMS Regional Research Conference Panel	Dr. Susanne Brenner	1995, 1999
NSF Career Award Panel	Dr. Jerrold Griggs	1997
	Dr. Susanne Brenner	2001
NSF Panel for Proposals in Combinatorics	Dr. Jerrold Griggs	1999
NSF Computer and Information Science and Engineering Panel	Dr. Douglas Meade	2000–present
NSF Interdisciplinary Grants Panel	Dr. Susanne Brenner	2002
NSF CCLI Panel	Dr. Susanne Brenner	2002
NSF IGERT Panel	Dr. Matthew Miller	2000
NSF REU Sites Panels	Dr. Susanne Brenner	1997, 2000
IDR/NSF Member at Large	Dr. Robert Sharpley	1998–present
DOE ASCI Site Visit Panel (Cal Tech)	Dr. Susanne Brenner	1999
Foundations of Computational Mathematics	Dr. Ronald DeVore	1999-2002 (Chair)
	Member-at-Large	2002–present
	Dr. Susanne Brenner	1999–2002 (Secretary)
	Member-at-Large	2002–present
IPAM (UCLA) Scientific Advisory Board	Dr. Ronald DeVore	1999–present
Association for Women in Mathematics Travel Grants Selection Committee	Dr. Susanne Brenner	1998–1999
Joint Policy Board for Mathematics Committee of Department Heads	Dr. Colin Bennett	1985–1988
Canadian Mathematical Society Board of Directors	Dr. Colin Bennett	1977–1980
DOE Soil Center Advisory Committee	Dr. Robert Sharpley	1995–1996
Partnership in Computational Science Steering Committee	Dr. Robert Sharpley	1991–1997
SIAM National Committee for Student Affairs	Dr. Jerrold Griggs	1988–1991
Vasil A. Popov Prize Selection Committee	Dr. Ronald DeVore	1994–present
	Dr. Pencho Petrushev	1994–present
	Dr. Robert Sharpley	1996–present
Council for the International Exchange of Scholars: Mathematics Advisory Committee	Dr. George McNulty	1995–1998
International Math Modeling Contest, Judge	Dr. Jerrold Griggs	1992–present
Canada/USA MathCamps for Talented High School Students, Advisor	Dr. Jerrold Griggs	1994–present
Mathematics Foundation of America	Dr. Jerrold Griggs	1996–present (now chair)
International Mathematical Competition in Modeling, Judge	Dr. Jerrold Griggs	1988-1990, 1992–present
Board of Directors, Mathematics Division, ASEE	Dr. Douglas Meade	1997–1999
William Lowell Putnam Competition Grader	Dr. Michael Filaseta	1996, 1997, 1999
SACS Accreditation Review Panels	Dr. George McNulty	1993, 1995

Service on Organizing or Program Committees for Mathematical Conferences

Name	Years of Conferences
Dr. George Androulakis	2001
Dr. Colin Bennett	1988
Dr. Susanne Brenner	1995, 1996, 1999, 2000, 2001, 2 in 2002
Dr. Ronald DeVore	1979, 1981, 1987, 1989, 1990, 1991, 1993, 1994, 2 in 1996, 3 in 1999, 2002
Dr. Stephen Dilworth	1990, 1997, 2001
Dr. Michael Filaseta	2 in 1993, 2001, 2002
Dr. Kevin Ford	1999, 2001
Dr. Maria Girardi	1996, 1997, 2001
Dr. Mohammed Ghomi	2001
Dr. Jerrold Griggs	1987, 1994, 1999, 2001
Dr. Ralph Howard	1996, 2001
Dr. Andrew Kustin	1988, 1995
Dr. Douglas Meade	3 in 1996, 1997, 2001
Dr. Matthew Miller	1988, 1995, 2001
Dr. George McNulty	1979, 1982, 1986, 1987, 2 in 1988, 1989, 1990, 1992, 2 in 1993, 2 in 1996, 2001, 2002
Dr. Peter Nyikos	1975, 1984, 1991, 1993, 1996
Dr. Konstantin Oskolkov	2001
Dr. Pencho Petrushev	1979, 1981, 1984, 1987, 1991, 2001
Dr. Anton Schep	2001
Dr. Robert Stephenson	1975, 1976, 1977, 1984, 1993, 2001
Dr. Laszlo Szekely	1996, 1999, 2001
Dr. Vladimir Temlyakov	2001
Dr. Ognian Trifonov	1999, 2001
Dr. Hong Wang	2 in 1997, 1999

University Recognition

Endowed Chair: Dr. Ronald DeVore The Robert L. Sumwalt Professor of Mathematics

USC Outstanding Faculty Member: Mary Ellen O'Leary , M.A. (1994). This distinction is awarded by the USC Educational Foundation.

Russell Award for Research in Science and Engineering: Drs. James Roberts (1979), Peter Nyikos (1990), Ronald DeVore (1995), and Jerrold Griggs (1999).

Michael J. Mungo Teaching Award: Drs. James Roberts (1998) and David Sumner (1999).

AMOCO Teaching Award: Dr. David Sumner (2001) and Dr. James W. Roberts (Finalist: 1996. 1997)

USC Freshman Advocacy Award: Mary Ellen O'Leary, M.A. (1991) and George W. Johnson (Finalist 1998).

South Carolina Honors College Awards: Outstanding Teacher: Dr. David Sumner (1981); Outstanding Science Teacher: Drs. David Sumner (1988), Ed Scheiblich (1989), James Roberts (1991).

Mortar Board Excellence in Teaching Award: Drs. David Sumner (1988, 1993), Michael Filaseta (1994), and Daniel Dix (1997).

Lilly Foundation Teaching Fellows: Drs. Maria Girardi (Junior Fellow 1993–94), Douglas Meade (Junior Fellow 1994–95), and James Roberts (Senior Fellow 1993–94).

AMOCO Outstanding Graduate Teaching Assistant: Margaret Reese (1989)

The Graduate School's Outstanding Graduate Student Award: Dr. Zhiying Zhao (1991); Dr. Marius Mitrea (1992); Dr. Zsolt Lengvárszky (1994); Dr. Angel Kumchev (2001).

Sigma Xi Graduate Career Award in the Natural Sciences: Dr. Marius Mitrea (1993).

C. Faculty Contributions to Our Educational Mission

The tables on this page summarize the effort the faculty puts into our educational mission.

Student/Faculty Ratios

	Fall 1997	Fall 1998	Fall 1999	Fall 2000	Fall 2001
Total Enrollments (FTE)	839	712	823	798	754
Full-time Faculty (FTE)	37	37	37	36	35
Student/Faculty (FTE)	22.7	19.24	22.2	22.2	21.5
Instructional Staff (FTE)	49.2	50.0	49.8	49.6	50.2
Student/Instructional Staff	17.1	14.2	16.5	16.1	15.0
Total Credit Hours	12,302	10,463	12,136	11,755	11,103
Credit Hours/Faculty (FTE)	332.5	282.8	328	326.5	317.2

The table above shows a high student/faculty ratio. Excluding Law and Medicine, the university-wide Student/Faculty ratio (using full-time FTE faculty) stood at 15.9 for the 1999–00 year. That of the Department of Mathematics is roughly 40% higher. The table also reveals that we rely on part-time faculty and graduate teaching assistants to bring our student/teacher ratio into the range that, across the University, is achieved with permanent faculty alone. The credit hour figures shows a high level of productivity on the part of the Mathematics faculty.

Course Load: Courses/Faculty Ratios

	1997–98	1998–99	1999-00	2000–01	2001–02
Total Number of Sections	259	255	258	255	234
Full-time Faculty Sections	170	173	170	154	148
Part-time Faculty Sections	36	34	44	52	36
Graduate Assistant Sections	53	48	44	49	50
Full-time Faculty Courseload	4.3	4.3	4.3	4.05	3.90
Part-time Faculty Courseload	4	4.3	5.5	4.73	3.27
Graduate Assistant Courseload	2.4	1.92	2.3	2.13	2.38

The table reflect the typical 2 course load per semester for full-time faculty, as well as the 1 course load per semester for teaching assistants. The numbers are slightly higher because of courses taught by some during the summer sessions. This data does not include sections of thesis/dissertation preparation courses (MATH 798, MATH 799, and MATH 899).

Additional Instructional Responsibilities of the Faculty

These include: conducting formal reading courses for individual students, organizing and participating in informal research seminars, supervising Honors College theses, masters theses, and doctoral dissertations, supervising students in funded research projects, and participating in formal mentoring programs.

Teaching Evaluations

Teaching is evaluated through a system of student teaching evaluations in every course, and through a system of peer reviews. The Department employs the student teaching evaluation instrument developed by the College of Science and Mathematics. Every faculty member's teaching is evaluated as well through a system of classroom visits by other faculty members. These are done by committees of three faculty members and occur every three years on a regular basis, unless a faculty member desires more frequent peer review. The results of these evaluation processes figure heavily into tenure and promotion decisions, post-tenure review, and the salary raise process.

The Role of Part-time Faculty and Graduate Teaching Assistants

The Department employs about eight part-time instructors. These instructors teach evening courses, weekend courses, and some lower level courses during the day. Graduate teaching assistants teach no more than one course per term. To qualify, they must hold a masters degree or they must have completed 18 hours of graduate coursework in mathematics. Most often, they teach College Algebra, Precalculus, or MATH 170 (a finite mathematics course for students in business and the social sciences). Graduate students are also employed as recitation leaders in the calculus classes (a faculty member lectures to 60–70 students MWF and the recitation sections, of 30–35 students each, meet TTh). Graduate students are also employed as graders and work in the Math Lab, our walk-in help center. Graduate students must give an acceptable performance before a panel of faculty members (from outside the Mathematics Department) before they are allowed to teach.

Faculty members visiting from other institutions also teach in our program. Roughly, they take the places of permanent faculty members who are themselves on leave to visit other institutions.

D. Campus and Public Service by the Faculty

Members of the faculty take on a wide array of service roles. The professional service roles at the national level (service on editorial boards, national panels, and conference organizing committees) were described in the previous section. This section is devoted to other service roles beyond the Department level. Of course, the faculty shoulders all the service roles within the Department.

Service at the State Level

Faculty members have served on the South Carolina State EPSCoR Committee (which oversees certain large federally funded research programs in the state), the South Carolina Supercomputer Network Board, the Board of Directors for South Carolina Network for Educational Renewal, and the Advisory Board for a project at South Carolina State University currently pending with NSF's Historically Black Colleges and Universities-Undergraduate Program.

Consulting

Some research by faculty members is supported by grants from industry. Faculty members also undertake consulting for concerns including the following:

- Institute for Defense Analyses, Center for Communications Research.
- McCreary & Snow, Architects.
- Bierer & Associates, Engineers.
- Thinkwell (a software company).
- The Institute for Scientific Computation at Texas A&M University.
- The Departments of Anatomy and of Computer Science at the University of Wisconsin.

Community Outreach and Service

In addition to the courses it offers for both prospective teachers and for inservice teachers, the Department is also engaged in a number of support and outreach activities intended to strengthen mathematics education in South Carolina's schools.

High School Mathematics Contest: Each academic year the Department holds a one-day High School Mathematics Contest which draws some 300 high school students from across the state to the University. The efforts of roughly 20 faculty members and students, both graduate and undergraduate, our computer staff and part of our secretarial staff go into each contest. The College of Science and Mathematics and the College of Engineering and Information Technology provide financial support, including a four-year full-tuition scholarship to USC awarded to the Contest winner.

Practice Advanced Placement Calculus Exam: Each April or May the Department holds a Practice AP Calculus Exam in which 500 high school students from across the state come to the University. Orchestrating this event, as well as the High School Mathematics Contest, requires extensive coordination with participating high school teachers. Roughly 15 Department faculty members, graduate students, and undergraduate students, along with computer and secretarial staff contribute their efforts.

Ties with Professional Development Schools ("PDS"): For the last eight years our department has actively pursued ties with PDS's in coordination with the College of Education in order to produce the best possible course(s) for the prospective elementary teachers. Almost all of these undergraduates are required to take MATH 221. Three of our faculty members have interacted extensively with teachers at Hood Street Elementary, Pinckney Elementary, and Pontiac Elementary. This interaction has included "pen pal" journal exchanges, class visitations, student-prospective teacher "get-togethers," at least two successful grant proposals, and meetings to discuss the content of MATH 221.

Participation in the South Carolina Network for Educational Renewal and the National Network for Educational Renewal: The National Network for Educational Renewal (NNER), founded by John Goodlad at the University of Washington, promotes the idea of tripartite collaboration by public school teachers and faculty members in Education and in the Arts and Sciences, in the context of simultaneous renewal of schools and teacher preparation programs. The South Carolina Network for Educational Renewal is a member of the NNER and is a collaborative of five South Carolina Universities, namely USC, Benedict, Columbia College, Furman and Winthrop. One of our faculty members serves as a member of the Board of Directors for SCNER and represents the South Carolina Network as a member of the Institute for Educational Inquiry Leadership Team, working with the NNER to develop models for collaboration between colleges and universities in teacher education.

Faculty members serve as judges in the Regional Science Fair hosted by the University every year.

Faculty members are also active in local community organizations including the Audubon Society, Boy Scouts of America, Earth Day, the Filipino-American Association of Greater Columbia, Odyssey of the Mind, and the Sierra Club.

University Level Service

Members of the Department have served on a variety of University committees, including the following: the University Committee on Tenure and Promotion, the Graduate Council, Academic Standards and Petitions, the Faculty Committee on Instructional Development, the Financial Aid and Scholarship Committee, the search committees for various deanships and the University presidency, the award selection committees for the Russell Award (for faculty research) and the Michael J. Mungo Award (for faculty teaching), and the selection committees for Carolina/McNair Scholars, and for Goldwater Scholars.

The South Carolina Alliance for Minority Participation in Science and Engineering, a statewide program funded by the NSF, has been strongly supported by the Department since the inception of the program. Its purpose is to increase the number of minority students who are able to go on to graduate school in the sciences and engineering. This program has not only benefited from the teaching of our faculty, but also from their service in administrative and advisory roles.

Members of the Department are active in support of the University's Preston Residential College Program, as mentors for Carolina Scholars, as interviewers of prospective Honors College students, in the Lilly Foundation programs supporting teaching, and in USC's Dance Program and Conservatory. Department members also serve as faculty advisors for student organizations including the Math Club (and Pi Mu Epsilon), the Carolina Cycling Club, the Putnam Examination Team, the Filipino-American Student Association, and the Turkish Student Association.

Service to the College of Science and Mathematics

The College's former Associate Dean of Research, Dr. Colin Bennett, is a member of our Department. Faculty members have served regularly on College committees, including: the College Computer Committee, the College Grievance Committee, the College Space and Facilities Committee, and the College Committee on the Evaluation of Teaching.

Mathematical Research in the Department

Mathematical Research

The Department maintains a vigorous, well-recognized program of mathematical research. Members of the Department regularly publish in a wide array of journals, they are invited to address major international conferences, and to give colloquia and seminars at leading institutions around the world. In each of the last five years, the faculty published roughly 50 papers, gave roughly 40 invited conference presentations, and 20 colloquia or seminars at other institutions.

Mathematical research papers are regularly published in the following areas: approximation theory, commutative algebra, computational harmonic analysis, descriptive set theory, discrete mathematics, equational logic, differential geometry, function theory, functional analysis, number theory, numerical analysis, partial differential equations, and set theoretic topology. The Department is home to research groups of at least three faculty members in the following fields: approximation theory, computational harmonic analysis, discrete mathematics, functional analysis, differential geometry, number theory, and partial differential equations.

One indicator of the recognition accorded the mathematical work of the Department is that 12 faculty members have served on the editorial boards of 25 mathematical journals.

The Department has been fairly successful in obtaining external funding. At present 13 faculty members hold external research funding. According to information about external research funding published annually by the National Science Foundation, in every year since fiscal 1994 the University of South Carolina has ranked in the top 10 nationally in terms of the amount of funding from all sources for mathematical research.

Internal funding explicitly in support of research has declined over the last five years. This includes subscriptions to mathematical research journals, funding for travel to conferences, and funding for colloquium speakers. All of these areas have seen very significant losses due to across-the-board budget cuts within the University in response to very steep declines in the state appropriation for higher education.

The most important internal supports for research are a teaching load that accomodates research and a selection of faculty colleagues open to collaboration. The current teaching load is two courses per semester in addition to direction of graduate student research. Our teaching loads are a bit higher than those at most of our peer/aspirant institutions. Four or five of our productive faculty members work in relative isolation. Also, due to recent retirements and changes in research interests, our research in algebra is undertaken by just three faculty members.

The Industrial Mathematics Institute (IMI) exists within the Department for the purpose of fostering advanced research in areas of mathematics having the capacity or potential for industrial application, and for the purpose of facilitating the transfer of research results and expertise between the academic and industrial sectors. The IMI has longstanding collaborations with some of the nation's premier research institutes. For example, the IMI together with Princeton, Wisconsin, CalTech, and Stanford was awarded the nation's largest NSF KDI grant. The IMI also offers stimulating research seminars in a variety of pressing topics. More information about the IMI can be found in Appendix III.

Considered from a national perspective, the Department's research profile seems comparable with those at the University of North Carolina, the University of Georgia, and the University of Virginia, and perhaps at Georgia Tech, and North Carolina State University. Moving up will require building a larger graduate program with a larger and wisely selected faculty. The programs at the University of California at San Diego and at SUNY at Stony Brook show what can be accomplished at a public university of our size.

A brief description of each faculty member's mathematical research interests can by found in Appendix II. Detailed resumé's for each faculty member are included in a separate volume; these provide a fuller view of the Faculty's record of publications and presentations.

External Grant Support

Grants in Effect
Fiscal 2001–2002

Grant Title	PI	Source	Total Amount	2001–2002 Amount
Computation Science	DeVore	VP/Dean	$210,000	
Toward Ideal Data Representations	DeVore	NSF (Wisconsin)	320,583	$106,861
Advanced Wavelet Methods for Image and Signal Processing	DeVore	DoD/DEPSCoR	449,997	149,999
Algorithms in Nonlinear Approximation	Temlyakov	NSF	82,328	27,443
Estimating the Number of Lattice Points Close to a Curve	Trifonov	NSF	59,955	19,985
Image Processing for Digital Terrain Elevation Data	DeVore/Sharpley	ONR/DEPSCoR	449,997	149,999
Multiplicative Number Theory	Ford	NSF	61,000	20,333
Combinatorics with Applications	Griggs/Szekely	NSF	110,000	36,667
Theory and Application of Multigrid and Domain Decompostion Methods	Brenner	NSF	115,628	38,543
Isomorphic Theory of Banach Spaces	Androulakis	NSF	26,174	13,087
Functional Regularity-Entropy Solutions	DeVore	DoD	1,887,903	152,942
SCREMS Grant	Sharpley	NSF	44,741	14,913
Rapid Approximation, Registration, and Rendering	DeVore	ONR	144,205	144,205
A Numerical Environment with Significantly Improved Modelling	Wang	CHE	75,681	75.681
	Wang	Mobil	166,504	
Advanced Methods for Data/Image/Signal Processing	DeVore	ONR	305,884	
Image Processing for Digital Terrain Evaluation Data	DeVore	CHE/EPSCoR	48,727	
Compression of Geometric Data Sets	DeVore	NSF	150,000	
Mathematical Analysis of Data and Image Processing	DeVore	ARO	70,000	
Convexity Problems in Submanifold Geometry and Topology	Ghomi	NSF	97,000	
Approximation: Theory and Algorithms	Petrushev	NSF	60,000	
On the Factorization of Lacunary Polynomials	Filaseta/Meade	NSF	151,151	
Greedy Algorithms	Temlyakov	NSF	33,500	

The Climate of the Mathematics Department

The Department strives to provide a mathematically stimulating environment for all its students and faculty.

For the undergraduate students the Department sponsors the Math Club and Pi Mu Epsilon, a Mathematics Team for the Virginia Tech Mathematics Contest, a Putnam Examination Team, a COMAP Mathematical Contest in Modeling Team, and the possibility to become involved in ongoing research projects.

To attract and support more underrepresented groups to careers in mathematics, science, and engineering, the Department has given strong support to the statewide NSF funded South Carolina Alliance for Minority Participation (SCAMP) at the undergraduate level and the Graduate Assistance in Areas of National Need (GAANN) program sponsored by the U.S. Department of Education. SCAMP offered minority students financial support, bridge workshops in the summer prior to enrollment, a mentoring program, and the Calculus Workshops, now part of our regular course offerings (and open to all students). GAANN is a new program that offers fellowships with attractive stipends and careful mentoring. We now have 3 GAANN fellows.

Currently the Department is preparing a proposal for an NSF VIGRE grant.

The exchange of ideas plays a central role in the advancement of the mathematical sciences. For this reason, the Department sponsors a vigorous program of research seminars, colloquium speakers, and visiting scholars to support the graduate students and faculty.

Research Seminars focus on currently developing ideas, and allow participants (both graduate students and faculty) to become actively involved in ongoing research. Recent seminar topics have included analysis, approximation theory, geometry, logic, partial differential equations, set theory and topology, discrete mathematics, computational complexity, commutative algebra, and numerical pde's.

Colloquia The Department's colloquium series brings in several speakers from outside the University each month. They usually present some of their most recent research. Many mathematicians of world renown have been colloquium speakers during the last few years. Recent speakers include:

- Albert Cohen, Paris IV
- Wolfgang Dahmen, RWTH-Aachen,
- Peter Borwein, Simon Fraser University
- William T. Trotter, Arizona State University
- Gilbert Strang, MIT
- Sergei Konyagin, Steklov Institute
- Fred Roberts, DIMACS
- Edward Odell, University of Texas at Austin
- Richard Anstee, Univesity of British Columbia
- Eitan Tadmor, UCLA
- Andrzej Schinzel, University of Warsaw
- Andrew Granville, University of Georgia
- Peter G. Casazza, University of Missouri
- Alexander Bobylev, Keldysh Institute of Applied Mathematics, Academy of Sciences, Moscow
- Nigel Kalton, University of Missouri
- Lars Andersson, Royal Institute of Technology, Sweden
- Farhad Shahrokhi, University of North Texas
- Gyula Katona, Mathematical Institute of the Hungarian Academy of Sciences
- Péter L. Erdös, Mathematical Institute of the Hungarian Academy of Sciences
- Dmitriy B. Silin, Lawrence Berkeley National Laboratory and Moscow State University
- Geng Xu, Johns Hopkins University
- Alexandre B. Tchernev, Purdue University
- Erich Novak, University of Erlangen, Germany
- Peter Bjørstad, University of Bergen, Norway
- Robert Calderbank, AT&T Laboratory, Flarham, New Jersey
- J. Tinsley Oden, University of Texas, Austin

Visiting Scholars The Department regularly hosts visiting scholars from other institutions. They generally stay for one or more semesters, and are involved in the graduate program either through teaching graduate courses or participation in seminars. Recent visitors with teaching responsibilities include:

Vistors with Teaching Duties

Rostom Getsadze	Umeå University, Sweden
Gyula Katona	Hungarian Academy of Sciences
Sergei Konyagin	Steklov Institue
Denka Kutzarova	Bulgarian Academy of Sciences
Eva Matouskova	Czech Academy of Sciences
Peter Binev	IMI Postdoctoral Fellow
Dany Leviatan	Tel Aviv University
Anna Kamount	Polish Academy of Sciences
Ju Wang	Chinese Academy of Sciences
Cornelia Kaiser	University of Karlsruhe
John Lane	IMI Postdoctoral Fellow
Borislav Karaivanov	IMI Postdoctoral Fellow
Morten Nielsen	IMI Postdoctoral Fellow
Alexander Petukhov	IMI Postdoctoral Fellow

Recent research visitors to the Department and to the IMI include:

Long Term Visitors

Noriake Nagase	Hirosaki University, Japan	(April 1, 1998–March 31, 1999)
Hans Wallin	UmeåUniversity, Sweden	(September 27–October 26, 1998)
Peter Wingren	UmeåUniversity, Sweden	(October 15–November 25, 1998)
Koffi Fadimba	Université du Bénin, Togo	(October 16, 1998–January 13, 1999)
Xiang Ming Yu	Southwest Missouri State University	(January 11–May 31, 1999)
George Kyriazis	University of Cyprus	(January 11–June 30, 1999)
Vitaly Maiorov	Tel Aviv University	(Febuary 23–March 23, 1999)
Peter Wingren	UmeåUniversity, Sweden	(March 15–April 25, 1998)
Grigor Karagulian	Steklov Mathematical Institute	(March 16–May 15, 1999)
Idris Sharapudinov	Steklov Mathematical Institute	(March 16–May 15, 1999)
Zheng Wang	Insitute for Economics and Finance, Shandong, China	(August 1–December 31, 2000)
Andrzej Schinzel	Polish Academy of Sciences	(September 30–October 31, 2000)
Evje Steinar	Rogaland Research, Bergen, Norway	(July 1, 2000–June 30, 2001)
Lasse Borup	Alborg University, Denmark	(January 1–June 15, 2001)
Ying Kang Hu	Georgia Southern University	(January 1–May 15, 2001)
Weidong Zhao	Shandong University	(April 1–November 30, 2001)
Wenqui Wang	Shandong University	(March 1, 2001–Febuary 28, 2002)
Vladimir Tikhomirov	Moscow State University	(Fall 2002)
Amos Ron	University of Wisconsin	(2002–2003)
Lutz Weiss	University of Karlsruhe	(2002–2003)

Short Term Visitors

Wolfgang Dahmen	RWTH-Aachen, Germany	(Spring 1999, Fall 2000, Fall 2001)
Albert Cohen	Paris VI, France	(Spring 1999, Fall 2000, Spring 2001, Fall 2001)
Borislav Bojanov	Sofia University	(Spring 1999)
Ingrid Daubechies	Princeton University	(Fall 2000, Fall 2001)
Allan Pinkus	Technion	(Fall 2000)
Remi Gribonval	Paris VI	(Spring 2001)
Angela Kunoth	University of Bonn	(Fall 2001)
Sergei Konyagin	Moscow State University	(Fall 2001)

Conferences The Department hosted the Spring 2001 meeting of the Southeastern Section of the American Mathematical Society. The Hour Invited Speakers were David Brydges, Albert Cohen, Herbert

Edelsbrunner, and Daniel Kleitman. Carl Pomerance delivered the Erdős Lecture. There were ten special sessions across the broad range of mathematics, with nine organized by 16 members of the Department. Close to 300 mathematicians from 32 states and 23 countries came to the University to participate in this meeting.

In the Southeast region there are regular annual conferences in analysis, in number theory and in geometry. The Department hosts these meetings on a rotating basis with other universities in the region.

The Undergraduate Programs in Mathematics

1. Programs Offered.

The Department of Mathematics offers several programs of study leading to the degree of Bachelor of Science (B.S.). By combining a comprehensive education in mathematics with a strong foundation in liberal arts we provide a variety of educational experiences in both pure and applied mathematics. The programs of study prepare students for further graduate study in mathematics or related disciplines, employment by industry, business, or government, and for careers as secondary school teachers. In addition the Department offers a special five-year program leading to the Bachelor of Science degree and a Master of Science degree in mathematics. Admission standards for the major reflect the admission standards of the University.

All students are expected to have or to acquire a broad general knowledge of mathematics, including the elements of calculus, differential equations, linear and abstract algebra, mathematical analysis, discrete mathematics, and statistics. In addition to the General Major, mathematics majors may also select from one of the following additional tracks.

(1) Applied Mathematics Major. This track offers specialization in applied or computational mathematics. Elective courses must be chosen in such disciplines as numerical analysis, optimization, and partial differential equations. Majors in this track are encouraged to select a cognate or minor in computer science or statistics.
(2) Actuarial Mathematics Major. This major track was approved in 2001 and offers a program of study designed to prepare students for the actuarial professions in the insurance and financial securities industries. In addition to the required mathematics and statistics courses, this track also requires a Cognate or Minor in Risk Management and Insurance.
(3) Mathematics Education Major. In addition to the core courses, this program requires a course in number theory and geometry, and a 12 semester hour education component. Upon completion of the undergraduate degree, the student will then pursue the Master of Teaching degree in the College of Education. The education program is subject to review by NCATE.

In addition to the B.S. degree, the Department also offers a cognate and a minor in Mathematics, and a joint minor with the Department of Statistics on Actuarial Mathematics and Statistics. This minor is intended primarily for students majoring in Risk Management and Insurance in the School of Business.

2. Undergraduate Majors.

The number of undergraduate majors has remained relatively constant during the past five years. The average number of mathematics majors per year has been approximately 158 full time students, with an average number of 29 degrees awarded per year. This represents a 32% increase in the number of degrees awarded (22/year) during the period 1985–1989. For Fall 2002, the number of mathematics majors increased to 204—a 30% increase over Fall 2001. In the past 5 years, the average SAT score of mathematics majors has ranged from a low of 1063 (1997) to a high of 1145 (1999). Of the 157 declared mathematics majors during Fall 2001, 21 majors were enrolled in the Honors College and 46 majors were in the teacher preparatory program. For Fall 2001, the mean overall GPR for mathematics majors was 2.884 with 57 majors having cumulative GPR's over 3.00. Recent graduates of the program have found employment in industry or government, in school districts within South Carolina, or have gone on to graduate school in mathematics or other disciplines.

3. Advisement.

All declared mathematics majors are initially advised by the Undergraduate Director. Freshmen are usually advised during summer orientation, whereas transfer students are advised either upon admission to the program or during special advisement periods for transfer students. After this initial advisement, majors are assigned a permanent faculty member as their advisor. At present there are 15 faculty members serving as full time advisors with approximately 10 advisees each. Two Advisors are assigned to exclusively advise majors in the Honors College.

4. Course Offerings and Curricula.

All required major courses (Differential Equations, Linear Algebra, Abstract Algebra I, Analysis I, and Discrete Mathematics I) as well as Vector Analysis are offered each semester. The one year sequences in abstract algebra and in analysis are offered each academic year. The Department offers the remaining courses typically taken by majors at least once per year. Unfortunately, the number of majors is too low to support enrollment in courses not specifically required in a degree program. During the two summer sessions the Department attempts to offer several of the required courses and also one or more courses usually taken by secondary mathematics education majors.

All decisions on curricula are first made by the Undergraduate Advisory Council and then submitted to the faculty for approval. This includes all changes involving curriculum and new courses. Recommended changes are then forwarded to the Undergraduate Dean of the College of Science and Mathematics and then to the University Faculty Senate for approval. Textbooks for courses at the upper division level are selected by the faculty teaching the course, whereas texts for all service courses are selected by the appropriate textbook committee with final approval by the Undergraduate Advisory Council.

At present, there are no immediate plans for the addition of new programs. Although it may be desirable to develop new programs, the Department does not have sufficient faculty to staff the existing programs. Any new programs, such as Computational Mathematics, Mathematical Finance, or Operations Research, would require a significant expansion of the Department.

5. Strengths and Weakness of the Program.

Strengths:

- An active undergraduate program offering several major tracks.
- An excellent faculty offering high quality instruction for mathematics majors. A number of faculty have been honored with teaching awards in recent years, as detailed elsewhere in this document.
- A large number of good undergraduate majors, with a few excellent majors. Recent graduates of the program have gone on to graduate study in mathematics at the following institutions: Georgia Institute of Technology, Iowa State University, Massachusetts Institute of Technology, Texas A & M, University of California at Berkeley, University of Texas at Austin, and University of South Carolina.
- Several of our majors and recent graduates have also attained national recognition
  - NSF Graduate Fellowship: Jason Burns (1997)
  - Goldwater Scholarship Recipients: Katie Spurrier (2002), Brandon Fornwalt (2001), Erin Flickinger (2001), Ben Cohen (1997)
- On the 2000 Putnam Examination, the USC team was ranked 33rd out of 322 participating teams. Jason Burns finished first in the 1997 Virginia Tech Regional Mathematics Contest, and Jonathan Mason tied for 19th in the 2000 competition.
- On both the 2002 and the 2001 Mathematical Contests in Modeling sponsored by COMAP, our team (of first and second year undergraduates) was rated *meritorious*. This contest consists of two problems—a continuous modeling problem and a discrete modeling problem. In both years our team tackled the discrete modeling problem. In 2001, 281 teams worldwide attempted the discrete problem. Six were rated *outstanding*, 43 were rated *meritorious*, 65 were given *honorable mention*. On the 2002 contest our team placed 12^{th} out of 246 teams worldwide that attempted the discrete poblem. Again six teams were rated *outstanding*, 38 were rated *meritorious*, and 61 were given *honorable mention*.

Weaknesses:

- Too few majors for a university of this size. We should have 250–300 majors. Also, a number of our freshmen and sophomore majors are enrolled as majors because they were denied admission to Business Administration or Engineering. The small number of majors limits our course offerings. Some important courses such as Nonlinear Optimization and Discrete Optimization are offered only occasionally, whereas other courses such as Differential Geometry and Mathematical Logic are rarely offered.
- Too many service courses are taught by graduate assistants or adjunct faculty. During the Fall 2001 semester, of the regularly scheduled courses, 68 sections were taught by 32 full-time faculty, 1 section was taught by a faculty member from statistics, 16 sections were taught by 7 adjunct faculty, 3 sections were taught by 3 post-doctoral appointments, and 21 sections were taught by 20 graduate assistants. Twelve sections taught by graduate students and adjunct faculty included these courses: the Calculus for Business and the Social Sciences, Finite Mathematics, and Mathematics for Elementary School Teachers. These courses should be taught by permanent faculty.

- Too few faculty to develop new programs or innovative courses. All of the current faculty are required to teach existing courses—little scope is left for innovation.
- Facilities. Currently the Department has sufficient space to accommodate the faculty and graduate students. There are also sufficient classrooms so that all the upper division and graduate courses can be taught in LeConte. However, maintenance of the facility is deplorable, and some of the facilities are too small. In particular, the faculty lounge is so small that most social events in the Department must be held in an adjacent classroom.
- Computing. There is still a lack of undergraduate access to computing. Our biggest problem is the lack of space to install new computer labs. At present it would not be possible to teach the calculus sequence with a required computer lab.
- Class size in Business Calculus and in Calculus I and Calculus II is too large. Currently, the enrollment in Business Calculus is about 60 students per section when taught by a faculty member. Every semester there are at least one or two sections of College Algebra with enrollments of 180 students. In Calculus I and II, each lecture section is between 60 and 70 students, whereas the recitations sections are at size 30–35. In the Honors College, enrollment in all mathematics courses is limited to 20 - 28 students per section.

6. Goals for the Undergraduate Program.

(1) **Increase the number of good undergraduate majors.** To accomplish this, there are several steps the Department should take.
   - The Department needs to take a more active role in recruiting at the high school level. The mathematics contest for high school students is a positive step. However more involvement with the high schools is required.
   - The Department needs to take a more active role in informing high school students and undergraduates that mathematics is a career option. We have just recently significantly expanded the careers web page providing a wide range of career options and salary information. We also have tentative plans to have a career night every fall semester.
   - Consider new and innovative courses for both majors and also for students in liberal arts. For example, a course on mathematical perspectives (1 credit hour) in which faculty are invited to talk on any subject of interest.
   - Set up progression requirements. Currently, the Department only has retention requirements. As a consequence, too many majors leave the difficult courses for their senior year creating the intolerable situation of having students ready to graduate except for the fact that they cannot pass the abstract algebra or real analysis course.

(2) **Increase the number of minors in mathematics.**

(3) **Eliminate College Algebra in its current format.** There is a lot of circumstantial evidence to indicate that this course is not effective. Students that enroll in the course are typically among the weaker students at the University. Large lecture sections cannot help these students. The Department either needs to expand the number of sections of Math 111I, or to find more innovative ways to teach the course. In Fall 2002 the Department is offering an experimental section of College Algebra using computer based self-paced instruction. A similar method of instruction is under consideration for our precalculus course.

(4) **Decrease section sizes in Calculus I and II to a size comparable to the Honors College.** At a minimum, lecture sections in the calculus sequence should be capped at 40 students, with a maximum of 20 students in each recitation section. Ideally, calculus should be taught in section sizes of 30 with a TA assigned to assist with recitations, etc. Enrollment in Vector Calculus and Elementary Differential Equations should be limited to 25 students per section.

The Graduate Programs in Mathematics

1. Degree Programs Offered

The Department of Mathematics offers programs of study leading to the M.S., M.A., and Ph.D. degrees in traditional and applied areas of mathematics. In addition,there are two teaching-oriented non-thesis degrees–the Master of Mathematics(M.M.) and the Master of Arts in Teaching (M.A.T.), an interdisciplinary program offered in conjunction with the College of Education. All master's degrees require 30 semester hours of course work, and the M.S. and M.A. require a thesis.The M.A.T. degree requires an additional twelve hours of student teaching.

For the M.S. or M.A. degree in mathematics, programs of study can be chosen from all of the traditional areas of mathematics or from applied mathematics and numerical analysis.

Students emphasizing applied mathematics are encouraged to choose a cognate such as computer science, statistics, or a related discipline.

For the Doctor of Philosophy degree in mathematics, areas of research specialization may be chosen from:

- algebra (commutative algebra, varieties of algebras)
- analysis (complex analysis, functional analysis, harmonic analysis, operator theory, several complex variables)
- applied mathematics (approximation theory, differential equations, numerical analysis)
- discrete mathematics
- geometry (algebraic and differential)
- logic
- number theory
- topology

2. Admission to the Program

For admission into any of the MS, MA, or Ph.D. programs, applicants must have a bachelor's degree from an approved institution and should have an undergraduate foundation in mathematics equivalent to that of a mathematics major at the University of South Carolina. At minimum, this should include a course in abstract algebra or advanced calculus. A minimum B average in all college-level mathematics coursework is required for full admission.

For admission to the MM or MAT programs, applicants must have a bachelor's degree from an approved institution and they are expected to have completed a minimum of six semester credit hours of mathematics beyond multivariable calculus.

Applicants should submit scores on the Graduate Record Examination. The Subject GRE in Mathematics is strongly recommended, especially for applicants to the Ph.D. program. Applicants submitting Subject GRE scores in mathematics get preferential consideration for assistantship awards.

International applicants are also required to submit TOEFL scores. A score of at least 570 on the paper-based test (or 230 on the computer-based test) is required for admission, and a score of at least 600 (paper-based) or 250 (computer-based) is required for consideration for teaching assistantships.

All graduate assistantships are awarded on the basis of merit and are renewed annually, subject to review.

Graduate Admissions Data

	Fall 1998	Fall 1999	Fall 2000	Fall 2001	Fall 2002
Applied	65	43	45	54	51
Admitted	34	33	27	36	47
Attended	11	15	15	15	14
Mean Verbal GRE	550	488	480	451	495
Mean Quant. GRE	729	729	670	697	752
Mean V+Q GRE	1279	1217	1159	1148	1247
TOEFL	562	601	612	600	577

3. Graduates

Among the graduates of our Ph.D. program who have risen to positions of academic leadership are:

Joseph Cicero (Ph.D. 1971)	Department Chair at USC-Coastal Carolina
Celia Adair (Ph.D. 1979)	Dean and Department Chair at USC-Spartanburg
Laurie Hopkins (Ph.D. 1981)	Provost and Department Chair at Columbia College
Nieves McNulty (Ph.D. 1982)	Department Chair at USC-Aiken and at Columbia College
Patricia Blitch (Ph.D. 1983)	Department Chair at Lander University
David Rowe (Ph.D. 1987)	Department Chair at Wingate University
Colin Day (Ph.D. 1992)	Department Chair at Allen University
Paul Sisson (Ph.D. 1993)	Department Chair at Louisiana State University-Shreveport
Brian Beasley (Ph.D. 1995)	Department Chair at Presbyterian College

Among recent graduates of our Ph.D. program who have obtained postdoctoral positions at research universities are:

Marius Mitrea (Ph.D. 1994)	University of Minnesota
Guergana Petrova (Ph.D. 1999)	University of Michigan
Bojan Popov (Ph.D. 1999)	Vanderbilt University
Angel Kumchev (Ph.D. 2001)	University of Toronto
Jiangguo Liu (Ph.D. 2001)	Texas A&M University

The success of our Ph.D. program can also be measured by the number of research papers our graduates have published. For the period 1981–2002 MathSciNet lists over 400 such papers.

Graduate Degrees Awarded: 1996–2001

Degree	1996	1997	1998	1999	2000	2001	Six Year Average
Masters Level	15	11	8	15	13	8	11.6
Doctoral	4	9	6	6	4	7	6.0

4. Frequency of Course Offerings and Program Changes

The courses or course sequences which are required for the various graduate degrees are offered every year. Topics courses on current research topics are offered as demand and enrollment warrant.

The only substantial change in our degree requirements in the past five years has been a change in the Ph.D. Qualifying Examination. An option was introduced to allow students to choose to be examined either on numerical linear algebra or on groups and rings (the other required topics, abstract linear algebra and real and complex analysis, remain unchanged). This was implemented to allow students interested in applied analysis to acquire a mastery of numerical linear methods early in their program. These students are still required to complete the coursework in groups and rings. In support of this option, we introduced a new course, MATH 706, on numerical linear algebra.

5. Graduate Assistantships

Awards are made on a competitive basis as determined by the departmental Graduate Advisory Council. Nine month stipends for the 2001–02 academic year were

$13,800	New assistants
14,300	Assistants admitted to candidacy for the Ph.D.
15,100	Assistants who have completed the Ph.D. Comprehensive Examinations

These stipends were supplemented by a $70,000 one-time appropriation from the Dean of the College, increasing academic year stipends to $15,300, $16,600, and $17,400 respectively. Summer stipends range from $2,200 to $2,500 depending on assignment. The IMI supports some doctoral students for the academic year as research assistants, and many students are supported by research grants during the summer with stipends ranging from $2,500 to $4,500. The Department also supports a few grading assistants with academic year stipends of $6,500.

Each semester graduate teaching assistants are assigned either two recitation sections of calculus (four contact hours) or one course (three or four contact hours). All teaching assistants are required to have completed at least 18 credit hours of graduate coursework before being assigned their own course.

6. Budget

During the 2001-02 academic year the Department supported 35 graduate assistants, one grading assistant, three computer assistants, and four library assistants. The total expenditures for for the 2001-02 academic year, including the supplemental appropriation, was approximately $533,000 of which $32,126 was spent on computer and library assistants. The amount budgeted for all graduate student support was $483,425, the same as for the 2000-01 academic year.

7. Strengths and Weaknesses of the Graduate Program

Strengths:

- Several recent Ph.D. graduates have obtained postdoctoral research appointments.
- A large number of Ph.D. graduates have risen to positions of academic leadership, especially in South Carolina.
- Many of our graduates have become productive research mathematicians.
- The Department's excellent faculty, actively engaged in high quality research, provides research opportunities for our graduate (and undergraduate) students.
- Several graduate students are supported as research assistants during the academic year, and more are supported over the summer.
- Frequent topics course offerings, as well as individualized reading courses, bring graduate students into active research areas, exposing them both to recent results and to challenging open problems.
- The Department has an active program of weekly research seminars, involving both faculty members and graduate students. In any given semester, seminars in six or seven areas might meet each week.

Weakness:

- Over the last five years the number of applicants to the graduate program has declined drastically.
- Most of the research oriented Ph.D. students have been foreign nationals.
- Very few fellowships are available to recruit outstanding applicants; none of these few are completely under the control of the Department.
- A fixed budget for the graduate program, coupled with increased stipends (to stay competitive), has shrunk the total number of supported graduate students to a critical level. As a consequence, standard second year graduate courses run less frequently than in the recent past.
- The supplemental appropriation from the Dean of the College is not guaranteed and it may not be used to advertise stipends.
- The computer and library assistants, funded under the graduate budget, generally are not enrolled in the graduate program of the Department.

8. Goals of the Graduate Program

- Obtain more fellowships for graduate students, preferably completely controlled by the Department.
- Increase the applicant pool through the establishment and nurturing of pipelines with high quality four year colleges and master's degree programs.
- Increase the total number of graduate students in the program, especially the Ph.D. program.
- Have the University Library fund graduate assistants working in the Mathematics Library.
- Increase the budget of the graduate program to $553,425, thus annualizing the one-time supplemental appropriation from the Dean of the College.

Department of Mathematics
University of South Carolina
Self-Study
November 2002

Appendices

Appendix I: Objectives and Organization of the Department of Mathematics

Mission Statement

The mission of the Department of Mathematics is to develop and disseminate knowledge about mathematics through its research, teaching, community support, and interaction with government and industry. Specific aspects of the mission are as follows:

(1) To advance the frontiers of mathematical science through the conduct of research in pure, applied, and computational mathematics.
(2) To disseminate mathematical knowledge through publication, teaching, consultation, and community interaction.
(3) To provide comprehensive education in mathematics at the baccalaureate, masters, and doctoral levels for students in the mathematics major, and to provide appropriate levels of mathematics education in support of other disciplines.
(4) To provide quality mathematics graduates in response to local, state, and national needs.
(5) To complement the educational missions of primary and secondary schools through programs of teacher training and enhancement in mathematics.
(6) To provide a resource of expertise in mathematics to industry, government, and schools.

Fundamental Goals

In support of its mission, the Department sets for itself the following goals.
Research:

(1) The mathematical research accomplished within the Department should be of high quality. The results of such research should be disseminated by publication in professional journals, in books, and in lectures given at professional meetings and at research institutions.
(2) The physical, human, and financial resources available to the Department should be sufficient to enable the Department to support successful programs of mathematical research, and to attract, retain, and support a research faculty of the first quality.

Degree Programs: The Department requires that all students in its degree programs be fluent and literate in English; students in the graduate programs are required also to be able to write clearly in English about mathematics. All students are expected to have or to acquire a broad general knowledge of mathematics, including the elements of calculus, differential equations, linear and abstract algebra, mathematical analysis, discrete mathematics, and statistics. Specific skills and levels of expertise in the various degree programs are as follows:

Ph.D. Degree: Demonstrated ability to accomplish original mathematical research; expertise in some specific mathematical discipline and working knowledge of related areas; proficiency with some computer programming language; demonstrated reading proficiency in French, German, or Russian.

Master's Degrees: Mastery of some substantial contribution to mathematics; working knowledge of some specific mathematical discipline and familiarity with related areas.

Bachelor's Degrees: Ability to recognize correct mathematical reasoning and sound formulation of mathematical concepts; ability to produce simple mathematical proofs; proficiency in a computer programming language.

Other Degrees: Mathematics plays an important role in support of other major programs throughout the University. The Department seeks to meet the specific mathematical needs of all such major programs.

Support for Education:

(1) Qualified instructors should be available for each class; enrollments should not exceed levels which deny the instructor the opportunity to provide students with sufficient individual attention; teaching loads should be nationally competitive.
(2) Sufficient numbers of graduate teaching assistantships, with nationally competitive stipends, should be available to support both the undergraduate and graduate educational objectives.
(3) Adequate numbers of undergraduate student scholarships and graduate student fellowships, at nationally competitive levels, should be available in order to attract students of high potential.
(4) Adequate physical, human, and financial resources should be available to support successful educational programs.

SERVICE: The Department expects faculty members, in service to their profession, to serve on editorial boards of mathematical journals, to referee articles submitted for publication, to review mathematical grant proposals submitted to funding agencies, to serve on organizing committees of professional conferences, to assume active positions in professional societies, and to otherwise undertake responsibilities in the profession. In service to the community, the Department takes as a goal the mathematical enrichment of the schools, particularly the secondary schools of South Carolina. The Department expects its faculty to render expert advice to government agencies and to business and industry when appropriate.

Organizational Chart

University of South Carolina
Dr. Jerome Odom, Provost

College of Science and Mathematics
Dr. Gerard Crawley, Dean

Department of Mathematics
Dr. Manfred Stoll, Chair

Dr. Susanne Brenner Assistant Chair	Undergraduate Program Dr. Douglas Meade Director	Graduate Programs Dr. Anton Schep Director	IMI Dr. Ronald DeVore Director
	Undergraduate Advisory Council	Graduate Advisory Council	IMI Executive Committee

Appendix II: The Research Interests of the Mathematics Faculty

Faculty Research Profiles

The Research Interests of George Androulakis

My research area is mainly Functional Analysis: in particular theory of infinite dimensional Banach spaces and operator theory. I have also worked on Mathematical Physics.

Let me briefly present my most recent results.

Th. Schlumprecht constructed the space S as the first known example of an arbitrarily distortable Banach space. He also showed that S is complementably minimal. An interesting open problem asks whether S is a prime space, namely whether S is isomorphic to every infinite dimensional complemented subspace. This is a difficult problem since there is no available information about the structure of the infinite dimensional complemented subspaces of S. As an effort to prove that S is prime, in a joint work with Th. Schlumprecht we showed that every block sequence in S that spans a complemented subspace, has a subsequence that spans a space isomorphic to S. As an effort to disprove that S is prime, in another joint work with Th. Schlumprecht we showed that there exist uncountably many non-isomorphic subsymmetric sequences in S.

W.T. Gowers and B. Maurey constructed the first example of a Hereditarily Indecomposable (HI) Banach space GM. Since every operator on GM can be written as a strictly singular perturbation of a multiple of the identity, they asked whether every operator on GM can be written as a compact perturbation of a multiple of the identity, i.e. whether GM is a solution to the well known "multiple of the identity plus compact" problem. In a joint work with Th. Schlumprecht we proved that there exists a strictly singular non-compact operator on GM. Moreover we proved that ℓ_∞ embeds in the set of operators on GM.

Let me now mention some interesting related open problems.

I would like to construct an HI space X based on the Hilbert space ℓ_2 in the same way that GM is constructed based on S. The space X will be a candidate for being a weak Hilbert HI space. Since the construction of strictly singular non-compact operators on GM is based on the construction of strictly singular non-compact operators on S, and ℓ_2 does not admit strictly singular non-compact operators, X will be a candidate solution to the "multiple of the identity plus compact" problem. Thus X will be a candidate affirmative solution to the well known invariant subspace problem. We do not know whether GM is an affirmative solution to the invariant subspace problem, or more generally we do not know whether strictly singular operators on reflexive spaces have non-trivial invariant subspaces. The fact that ℓ_∞ embeds in the set of operators on GM indicates that the "multiple of the identity plus compact" problem may not admit an affirmative solution. This will be the case if ℓ_∞ embeds in the space of operators of every infinite dimensional Banach space with a basis. This is trivially true if the basis is unconditional. We do not know whether ℓ_∞ embeds in the space of operators of the space of Bourgain-Delbaen, or of the space of Pisier, or more generally of every $\mathcal{L}_\infty$ space.

The Research Interests of Howard Becker

All of my research has been in the field of descriptive set theory. I have done research involving several different parts of this field, and also involving connections between this field and other parts of mathematics.

Descriptive set theory is the study of definable subsets of the real numbers, and of other Polish spaces. (This includes definable relations and definable functions.) It is a field which is partly set theory, partly recursion theory, partly general topology, and partly real analysis. The basic classes of definable sets are the classes of Borel, analytic, and coanalytic sets, but other classes of definable sets are also considered. Descriptive set theory sometimes involves the use of strong set theoretic assumptions: determinacy axioms, or, equivalently, large cardinal axioms.

My past research can be divided into three parts. The first part is what might be called "Cabal-type" descriptive set theory: the axiom of determinacy, the abstract theory of pointclasses, and set theory in models such as $L(\mathbf{R})$. ("The Cabal" is a nickname for a group of set theorists in the Los Angeles area.) This is all I did at the beginning of my career, up until about 1985. I still do it a little bit, but mostly I do other things. The second part concerns descriptive set theory in relation to specific examples of pointsets that occur naturally in analysis and topology, e.g., the set of pointwise convergent sequences, considered as a pointset in the space of all sequences of real-valued functions on the unit interval. This is what dominated my research from about 1985 to about 1992. I also still do a little bit of this, but mostly I have gone on to the third part of my research. Third, since about 1992, most of my research has been about the descriptive set theory of Polish group actions and their associated orbit equivalence relations. I wrote a book with A. S. Kechris involving this part of my research.

The Research Interests of Colin Bennett

Most of my research has been conducted in the area of Fourier analysis, a subject which, because of its remote roots in the theory of music, also goes by the name of harmonic analysis. I have long had an interest in the theory of interpolation of operators and its applications to harmonic analysis. Together with Dr. Robert Sharpley, I have co-authored one of the standard texts in the area. More recently, I have become involved with the theory of wavelets, which are fundamental mathematical building blocks that were discovered less than twenty years ago. I have an abiding interest also in the theory of waves on the surface of water—a subject which (like harmonic analysis) continues to offer new challenges, yet has origins that are older than science itself.

The Research Interests of Susanne Brenner

Prof. Brenner works in the areas of multigrid and domain decomposition methods and their applications to problems in computational mechanics. Her research has received uninterrupted funding from the National Science Foundation since she graduated from The University of Michigan in 1988. She is also the coauthor of a graduate text book in the mathematical theory of finite element methods.

The Research Interests of Ronald DeVore

Ronald A. DeVore is the Robert L. Sumwalt Chaired Professor of Mathematics and Director of the Industrial Mathematics Institute at the University of South Carolina. He received his Ph.D. degree from Ohio State University in 1967 and has been at the University of South Carolina since 1977. He has published over 100 research articles and five research monographs in the areas of approximation theory, harmonic analysis, nonlinear partial differential equations, numerical analysis, and image processing.

His recent research interests center on fast wavelet based algorithms for image processing and numerical methods for nonlinear partial differential equations.

Image Compression

Together with Ingrid Daubechies and Mike Orchard at Princeton University, we have initiated research into issues of compression which will result in the next generation of techniques for image compression.

A paper written with Albert Cohen (Paris VI), Wolfgang Dahmen (Aachen), and Ingrid Daubechies gives an optimal encoder to be used in wavelet compression and proves its optimality in terms of rate distortion. This paper explains the success of the Said-Pearlman encoder which is generally regarded as the most effective wavelet based encoder.

Analogue to Digital conversion

An important problem in Communication is the conversion of analogue signals to digital. With Ingrid Daubechies, we are developing Delta-Sigma converters for this purpose. Our main contribution is to show how the design of such converters is connected with certain problems in mathematics called redundant representations and then to use this model for designing converters.

Redundant Systems

With Ingrid Daubechies, Amos Ron (U. Wisconsin, Madison), and Dave Donoho (Stanford), we are exploring the use of redundancy in image processing. The idea is that redundancy allows the flexibility to allow the image processing algorithm to depend on the image itself - a form of high nonlinearity.

Research has been funded by the National Science Foundation, the Office of Naval Research, the Air Force Office of Scientific Research, the Army Research Office, the Advanced Research Projects Agency, the North Atlantic Treaty Organization, and the Israeli National Science Foundation.

The Research Interests of Stephen Dilworth

My research interests lie in Functional Analysis, particularly Banach Space Theory. A large part of my research has been an investigation of the functional analytic properties of certain classical Banach spaces, such as the sequence space ℓ_1 and the Lorentz function spaces $L_{w,1}$. I have also worked on problems at the interface of Banach space theory and related areas such as convexity and probability.

Recent work has focused on a blend of isometric and nonlinear phenomena in Banach space theory which arise, for example, in fixed point theory and in the consideration of the stability of functional analytic properties under small perturbations.

The Research Interests of Daniel Dix

My research is focussed around mathematical questions arising from the study of biological molecules and their interactions. There is the fundamental question of how the partial differential equations of molecular quantum mechanics determine the geometry of a molecule. Then there are many unresolved questions in pure molecular geometry, such as whether certain geometric arrangements of atoms can be proved to exist. Then there are many interesting issues related to the dynamics of molecules. An example is how an unfolded protein behaves in a container with many water molecules. Many concepts from the theory of dynamical systems can be brought to bear on this and related questions. Finally the issue of information and design in biomolecules and their interactive networks deserves a careful mathematical treatment. Even though these topics appear to be driven totally by applications to biochemistry, my conviction is that they will lead to very intersting new mathematics.

The Research Interests of Michael Filaseta

The main areas of research include estimates for the number of lattice points close to a curve, gap results associated with special sequences of integers, the irreducibility of classical polynomials over the rationals, and algorithms for classifying and determining a factorization for lacunary polynomials. Other areas of research include applications of transcendental number theory, aspects of the *abc*-conjecture, additive number theoretic problems, and certain combinatorial questions. We mention two noteworthy results from his research below.

The gap problem for squarefree numbers is to determine the smallest $\theta > 0$ such that for every x sufficiently large, the interval $(x, x + x^\theta]$ can be shown to contain a squarefree number (an integer not divisible by the square of a prime). In the 1950's, results were obtained by K. F. Roth, H. E. Richert, and R. A. Rankin, the latter of which established that one could take any $\theta > 2/9 = 0.222\ldots$ in this problem. Their techniques made use of exponential sums. As exponential sum techniques improved over the years, some improvement on this gap problem followed. But even in 1988, the best result with the new exponential sum methods, obtained by S. W.Graham and G. Kolesnik, was that any $\theta > 1057/4785 = 0.2208986\ldots$ was admissible. O. Trifonov and M. Filaseta showed that another approach, making use of finite differences rather than the use of exponential sums, could be used to improve on this and other related problems. In particular, they showed that any $\theta > 1/5 = 0.2$ is admissible in the gap problem for squarefree numbers. They received the Distinguished Award of the Hardy-Ramanujan Society for their work on this problem.

In the early 1950's, E. Grosswald conjectured that the Bessel polynomials $y_n(x)$ are irreducible over the rationals for every positive integer n. M. Filaseta showed that all but possibly finitely many $y_n(x)$ are irreducible. More recently, he and Ognian Trifonov settled Grosswald's fifty year old conjecture in the affirmative. They established that for every positive integer n and every choice of integers $a_0, a_1, \ldots, a_n$ with $|a_0| = |a_n| = 1$, the polynomial

$$\sum_{j=0}^{n} a_j \frac{(n+j)!}{2^j (n-j)! j!} x^j$$

is irreducible over the rationals. Grosswald's conjecture follows from considering the special case that every $a_j = 1$. The method developed by M. Filaseta combines the classical use of Newton polygons for such questions with information on the distribution of primes. The same technique has now brought about improvements on some irreducibility theorems of I. Schur and has led also to irreducibility theorems for the generalized Laguerre polynomials.

The Research Interests of Mohammed Ghomi

Most of my research centers around notions of convexity in differential geometry, topology, or partial differential equations. One of the recent results in this area is my solution to the "shadow problem" which had been studied by H. Wente since 1978. Currently I am writing several papers in joint work with Stephanie

Alexander (University of Illinois at Urbana-Champaign), Bruce Solomon (University of Indiana) and Ralph Howard (University of South Carolina). The work with Stephanie Alexander is concerned with a new "convex hull property" for hypersurfaces, as had been conjectured in my thesis. The work with Bruce Solomon gives a new characterization for quadric surfaces in terms of "skew loops" which had been constructed to Solve the shadow problem. And the work with Ralph Howard is currently on "convex unfoldings" of space curves, and "knot energies"; in particular, we have found a solution to a conjecture of Michael Freedman in this area.

The Research Interests of Maria Girardi

Dr. Girardi's research focuses on functional analysis. Her speciality is Banach space theory and the applications of Banach space theory techinques to other branches of analysis. She explores

(1) geometric properties of a Banach space such as: Radon-Nikodým Property, Complete Continuity Property, Kreĭn-Mil´man Property, and uniform convexity,
(2) structural properties of a Banach space such as: ℓ_1 embedding into the space, the space having a Schauder basis, and nice biorthogonal systems in the space,

and determines applications of such properties to various branches of functional analysis, such as

(3) fixed point theory,
(4) semigroup theory and evolution equations,
(5) approximation theory.

The Research Interests of Jerrold Griggs

Professor Griggs works on a broad range of problems from combinatorics and graph theory, with an emphasis on extremal and structural questions for graphs, hypergraphs (set systems) and ordered sets. He is always on the lookout for interesting discrete problems that arise in connection with applications to biology or to communications, and because of this, he has been on the editorial board of the SIAM Journal of Discrete Mathematics. Likewise, he is one of the founding editorial board members of the new electronic journal of combinatorial number theory, Integers, because of his activity in this area.

Griggs is recognized internationally as an expert on the Sperner theory of ordered sets. In the last several years, considerable attention has been attracted by his work on certain problems of database security: Certain natural problems of maximizing the usability of a statistical (numerical) database, while avoiding compromise of the database, can be attacked successfully by applying Sperner theory and other combinatorial methods. Interesting new problems in combinatorial number theory are arising in connection with this project that concern concentrating the subset sums for a set of vectors.

Griggs has been active for years in the area of generalized graph labellings. He investigates problems that arise in connection with the most efficient assignment of channels to a network of radio transmitters. With the explosion of interest in cellular communication networks, such problems have become increasingly important.

The discrete problems arising in molecular biology that Griggs has worked over the years include those connected with planar folding of single-stranded nucleic acids (an early application of dynamic programming), and with the design of algorithms for the alignment or physical mapping of biological sequences.

Griggs has been steadily productive in training graduate students, organizing conferences, training talented high school students (through the Mathematics Foundation of America and its Mathcamp), and stimulating undergraduates (as a judge for the annual international modelling contest). He is a consultant at the IDA–Center for Communications Research, La Jolla, where he has spent one semester and four summers.

The Research Interests of Peter Harley

Dr. Harley's mathematical work has been in general topology.

The Research Interests of Ralph Howard

My research is centered on differential geometry and its connections with related parts of analysis, convexity and mathematical relativity. The greatest recent effort has gone into regularity questions coming from general relativity. As an example of such a question, let $\mathcal{H}$ be an event horizon in a spacetime. Then some important results in cosmology, such as the Hawking area theorem, also called the second law of black hole thermodynamics, have implicitly assumed that the horizon is rather smooth, say piecewise C^2. But recent examples have shown that there are horizons that are nowhere C^1. In a long paper *Regularity of Horizons and the Area Theorem* (written jointly with Piotr Chruściel, Erwann Delay, and Greg Galloway) we show that horizons have second derivatives almost everywhere in a suitable generalized sense. Moreover these generalized second derivatives behave in such a manner that classical proofs of Hawking and others can be seen to mathematical as well as physically correct. Work in progress involves getting a better understanding of the properties of horizons and some related regularity questions in Riemannian geometry.

In recent work with Mohammad Ghomi we show that the circles are the only minimizers of a large class of energy functionals on the space of closed curves. This settles a conjecture of Michael Freedman and his collaborators. The methods used in the solution are rather general and we hope that they will shed light on some other questions such as what is the length of the shortest rope of diameter one needed to tie a knot.

In work with Steve Dilworth and Jim Roberts the sharp constants for the stability theorem for convex functions are first given by Hyers and Ulam in 1952. This work leads to an effective and sharp method to estimate the distance (in the Hausdorff measure) of a set from its convex hull.

The Research Interests of Richard Hudson

My mathematical interests include class number formulas for quadratic and quartic number fields, comparative prime number theory, especially consideration of irregularities in the distribution of primes in arithmetic progressions and improvements in the legendary bound of Skewes, the use of Gauss and Jacobi sums to explicitly determine binomial coefficients modulo p, the distribution of quadratic and higher power residues, computational number theory, especially the distribution of zeros of the Riemann zeta function and Dirichlet L-functions and their applications in studying the distribution of primes and primes in arithmetic progressions. I also am interested in the history of mathematics and research in the use of elementary number theory, mathematical manipulatives, and other resources (especially the world wide web) to teach students in grade K-12, and to educate preservice teachers in the use of such techniques.

The Research Interests of George Johnson

My current research interests are in the area of developing software to implement algorithms that estimate parameters that appear in ordinary differential equation models. This project was started while I was on sabbatical leave at Rice University. The work was begun at Rice by Karen Williamson and Guangye Li under the direction of John Dennis. They developed the initial idea of using collocation schemes to reduce the differential equation constraints to algebraic constraints, and wrote the initial code to test the concepts. Guangye Li devoted his efforts to the possible parallelization of the algorithms. Both Williamson and Li have subsequently entered industrial positions and are no longer working on the project.

My work with the code development has been on three fronts. First, the initial code exhibited poor stability properties with respect to initial conditions and parameters. In the current version, the use of stability equations for the ODE's as a factor in determining the trust region radius for the optimization algorithm has helped to resolve these issues. Second, the problem of initial interval selection is still not satisfactorily resolved and is the subject of current theoretical efforts on my part. In particular, I have been investigating the use of the stability equations coupled with an ODE solver to assist in defining the initial subinterval selection. Finally, the development of a graphical user interface has been an ongoing programming component. I have developed a system for real-time graphics output while the code is executing. This provides for monitoring the progress of the algorithm toward a solution. I am currently designing and building an easy-to-use interface for data entry and problem selection.

The Research Interests of Marek Kossowski

The inverse function theorem implies that if the differential of a smooth mapping has maximal rank then the mapping is locally equivalent (up to smooth change of local coordinates) to a linear mapping. The Whitney-Thom-Boardman Theory (developed some thirty years ago) locally classified smooth mappings with critical points (i.e. the differential drops rank on a small set). The Hormander-Arnold Theory adapted these ideas to study multivalued solutions to Hamilton-Jacobi PDE. My research extends these ideas to study how more general PDE's control the critical points in single and multivalued solutions. This requires a preliminary classification of candidate singular solutions which is quite involved, and is tractable only in low dimensions. Existence of such solutions is established via Cartan-Kahler methods or some special property of the given PDE. This approach is quite natural for the the PDE encountered in classical mathematical physics and differential geometry (e.g. the differential geometry of submanifolds with singularities, spacetime singularities, and electromagnetic fields.) During the classification step global invariants can be encountered indirectly and new insights may be deduced. (e.g., an error in Boy's extension of the Gauss Bonnett Theorem for singular surfaces was recently corrected).

The Research Interests of Andrew Kustin

Free resolutions have served both as a major tool and as interesting objects in their own right in the development of commutative algebra over the last thirty years. Professor Kustin has concentrated his efforts on finite resolutions, with particular emphasis on the multiplicative structures they may support and their role in linkage theory. Some of his results have had applications to infinite resolutions as well by way of the study of Poincaré series. He has begun and will continue to expand the scope of his research to investigate entire families of resolutions, especially resolutions of objects such as algebras in the linkage class of a complete intersection, algebras defined by residual intersections and powers of perfect ideals, canonical classes and other class group elements, and modules of finite length over rings of a fixed dimension.

The Research Interests of George McNulty

The bulk of my research lies at the confluence of algebra, discrete mathematics, mathematical logic, and computer science. I am particularly interested in the computational and logical limitations inherent in the expression of mathematical concepts. Of my mathematical contributions some of my favorites address problems in algebra and discrete mathematics, apart from any computational or logical considerations. The largest part of my work is in equational logic, where finite axiomatizability, decision problems, and the structure of the lattice of equational theories have attracted most of my efforts. In discrete mathematics, I have made contributions to the computable theory of ordered sets, the study of maximal sublattices of finite distributive lattices, the combinatorial properties of strings of symbols (notably to the investigation of patterns that can be avoided in very long strings), and to graph theory. In the purely algebraic setting, I have contributed to the theory of natural dualities (an outgrowth of Stone's Representation Theorem for Boolean algebras) and to the study of subdirectly irreducible groups in varieties generated by finite groups. For the last seven years I have been involved as well in a collaboration with researchers in the School of Medicine and at the state Department of Mental Health to apply algebraic methods in the analysis and display of large sets of data.

The Research Interests of Douglas Meade

Professor Douglas Meade is an applied mathematician whose primary interest is the analysis of nonlinear systems of partial differential equations that arise in diverse areas of application. He has developed modeling procedures for the formulation of physically realistic, numerically efficient, and accurate local boundary conditions for wave propagation problems on unbounded domains. Professor Meade has studied systems of nonlinear and degenerate systems of reaction–diffusion equations that arise in the modeling of an infectious disease. His most recent work in this direction involves a comparison of vaccination strategies. A third area of interest is the development and implementation of efficient irreducibility algorithms that depend more on the number of terms in the polynomial than the order of the polynomial. The efficient implementation of these algorithms requires a balance between symbolic (Maple) and numerical computation. Another project that involves this hybrid symbolic − numeric computation is the development of a more complete set of Maple routines for the solution of boundary value problems for ordinary differential equations.

Research Interests of Matthew Miller

Since obtaining my PhD in 1979 I have worked in commutative algebra, an abstraction of sorts of the study of the geometry of curves and surfaces (in all dimensions) that are defined by polynomials. I began with the investigation of the multiplicative structure of free resolutions, but eventually turned almost exclusively to the study of their numerical invariants, betti numbers, and from these to the almost combinatorial aspects found in the underlying Hilbert functions. This culminated in my sabbatical year 1999–2000 with the close supervision of my student, Kimberly Presser, now at Shippensburg University, on the growth of Hilbert functions.

Since about 1994 I began for both intellectual and pedagogical reasons to shift my interests to modeling problems in ecology. However, lacking the necessary biological training, I took my sabbatical here at USC in Dr. David Wethey's lab, and there I collaborated closely with his PhD student Steven Viscido, on flocking behavior in fiddler crabs. This resulted in two publications. Moreover, I feel that through course work, seminar participation, and active collaboration, I have trained myself as a competent mathematical colleague for a modeling oriented biologist, at least in certain sub-disciplines that might generally be subsumed under "ecology". To this end, I studied Population Genetics, Biological Oceanography, and Cellular and Molecular Biology. With my only formal background being high school biology and chemistry (many years ago, but after the discovery of DNA!) and Evolution and Ecology, even these undergraduate courses added to my ability to "speak the language". Additional upper level seminars, one with Dr. Woodin on benthic ecology, one with Dr. Raguso on sense perception and behavior, and one with Dr. Helmuth on physical ecology, exposed me to some of the classic literature, and perhaps more significantly, to the current literature, of which we read and discussed a great deal. How one reads biology, identifying the central questions, methods, and conclusions, is a very different process from how we read a mathematics publication, so again I feel I gained an appreciation for, and some competence in, a new research culture, though still far from a specialized one. I participated actively, and I hope I had a positive impact on the discussions. I also helped organize a less formal, but still intense, Journal Reading Club, in which we met weekly to read papers from the biological literature that had an apparently heavy mathematical component; this club has continued into the present semester. In this way, I hope I have helped bridge the gap between the biologists and the mathematicians, where they are providing the context and the principal questions and I am providing technical, sometimes critical, perspective on the mathematics. Finally, Dr. Wethey is now gathering data on the barnacle distribution at the ends of the Cape Cod channel; I expect to play a role in the modeling of the distribution of the species that he finds there.

The Research Interests of Peter Nyikos

I am especially active in that part of topology which is involved with set-theoretic consistency and independence of some very basic topological concepts. This is part of what I call the legacy of Kurt Gödel, who first showed that there are mathematical statements whose truth or falsity cannot be decided on the basis of the axioms on which all of mathematics up to Gödel's day was based. Although over sixty years have passed since then, no one has come up with any new axioms that are generally seen to be true. However, in the meantime, a multitude of statements in mathematics, including some in almost every one of the main areas of pure mathematics, have been shown to be undecidable on the basis of the generally accepted axioms. Many of them are easy to state, in fact easier to state and more fundamental to some branches of mathematics, than most of the true statements that are being proven in these branches today. Topology is one branch that has been completely revolutionized in the past three decades as a result. Ever since 1977, I have been a leading researcher in the part of topology that deals with these consistency and independence results.

My other research interests include general topology, set theory, combinatorics, and the theory of Boolean algebras.

The Research Interests of Konstantin Oskolkov

Fourier Analysis, Approximation Theory, (classical polynomial and spline approximation in integral metrics, and almost everywhere optimal quadrature formulæ), Analytica Number Theory in application to special problems of Harmonic Analysis, Partial Differential Equations of Schrödinger type, chaotic features of their solutions.

The Research Interests of Pencho Petrushev

Since 1991 Dr. Petrushev as focussed his research in the following areas:

(1) Nonlinear approximation by rational functions, splines, and wavelets and related function spaces. Nonlinear approximation from libraries of bases.
(2) Schauder bases and unconditional bases for different function spaces. Wavelets.
(3) Image compression.
(4) Approximation by ridge functions and in particular neural networks.

(5) Description of the behavior of polynomials of best L_p-approximation and in particular Fourier sections.
(6) Multivariate trigonometric polynomial and wavelet approximations with frequencies for hyperbolic cross.

The Research Interests of James Roberts

Professor Roberts has worked primarily in F-space theory. He has also done work in the study of spaces of analytic functions and the study of almost convex functions. He has solved the following four long outstanding open problems: the Krein-Milman Problem, the Rigid Space Problems, the Cyclic Inner Function Problem and the uniformly exhaustive part of Maharam's Problem (posed by M. Talagrand). He won the 1979 Russell Award for the first of these. He is the author (with N. J. Kalton and N.T. Peck) of *An F-Space Sampler*.

The Research Interests of Anton Schep

I am generally interested in the areas of Functional Analysis and Operator Theory. In particular my published research includes papers on:

- the study of linear integral operators on Banach function spaces.
- positive operators and C_0–semigroups of positive operators on Banach lattices.
- spectral properties, and compactness properties of special classes of operators, such as disjointness preserving operators.

The Research Interests of Robert Sharpley

Professor Sharpley's research interests have included classical Fourier analysis, approximation theory, classical and numerical analysis of PDE and some applications to modeling seismic waves the transport of contaminants in groundwater and the atmosphere, His current work involves multiresolution analysis, wavelets and their applications to image processing.

Professor Sharpley has published two research monographs and approximately fifty research articles in journals such as Journal of Functional Analysis, Transactions of the American Mathematical Society, Memoirs of the AMS, Annals of Mathematics, Studia Mathematica, Monthly Weather Review, Journal of Approximation Theory, Proceedings of the AMS, Advances in Water Resources, Supercomputing, IEEE Parallel and Distributed Technology, SIAM J. Scientific Computing, and the Bulletin of the AMS.

He has been the Principal Investigator on Grants from the National Science Foundation (Modern Analysis Program, Classical Analysis Program, Special Projects Program), Department of Energy (Mathematical, Information, and Computer Sciences), and the Department of Defense (Office of Naval Research, Army Office of Research). He is currently a Member at Large of the National Science Foundation's Center for Ideal Data Representations, an editor of Constructive Approximation, and a consultant for the Department of Anatomy of the School of Medicine at the University of Wisconsin.

The Research Interests of Paul Sperry

Dr. Sperry's mathematical work has been in the theory of Abelian groups.

The Research Interests of Robert Stephenson

For a property $\mathcal{P}$ of topologies, a $\mathcal{P}$-space $(X, \mathcal{T})$ is called: *$\mathcal{P}$-closed* if $(X, \mathcal{T})$ is a closed subset of every $\mathcal{P}$-space in which it can be embedded as a subspace; *$\mathcal{P}$-complete* if there does not exist an extension space $(Y, \mathcal{U})$ of $(X, \mathcal{T})$ such that $(Y, \mathcal{U})$ is a $\mathcal{P}$-space and $Y \neq X$; and *$\mathcal{P}$-minimal* (*$\mathcal{P}$-maximal*) if there does not exist a topology $\mathcal{S}$ on X strictly weaker (stronger) than $\mathcal{T}$ for which $(X, \mathcal{S})$ is a $\mathcal{P}$-space. For many properties $\mathcal{P}$, compact $\mathcal{P}$ implies $\mathcal{P}$-minimal, $\mathcal{P}$-minimal implies $\mathcal{P}$-closed, and $\mathcal{P}$-closed and $\mathcal{P}$-complete are equivalent. For some properties $\mathcal{P}$, $\mathcal{P}$-closed also implies $\mathcal{P}$-minimal or compact. Stephenson or Stephenson and co-authors have characterized or developed much information about the structure, properties, and extent of these spaces for a large number of properties $\mathcal{P}$ such as pseudocompact, feebly compact, countably compact, topological group, metrizable, symmetrizable, totally disconnected, or first countable.

In articles by him or by him and Saks or Vaughan, Stephenson has studied and obtained results about the behavior of initially κ-compact spaces (a topological space X is called *initially κ-compact* provided that every open cover of X of cardinality $\leq \kappa$ has a finite subcover).

With Harley, Stephenson defined and extensively studied and derived the properties of a large, well-behaved family of spaces which they called $\mathcal{F}$-spaces. They showed $\mathcal{F}$-spaces include Arhangel′skiĭ's symmetrizable spaces, Moore spaces, and many spaces important in topology, such as the Michael line, the Sorgenfrey line, the two-arrow space, and Alexandrov's double. In subsequent articles Stephenson obtained results concerning the behavior, cardinality, and separability of these types of spaces when they satisfy certain compactness conditions.

Here are a few of the specific results obtained. With Scarborough, Stephenson proved that for $\mathcal{P}$ = metrizable or completely normal, every $\mathcal{P}$-minimal space is compact. Stephenson proved that a dense subgroup H of a compact group G is a minimal group iff for every closed normal subgroup N of G, if $N \cap H = \{e\}$, then $N = \{e\}$. Using the latter, he proved that there exist non-compact, minimal groups by proving that the subgroup H of elements of finite order of the circle group is a non-compact, minimal group. He constructed examples to prove that there exist two minimal Urysohn spaces whose product is not minimal Urysohn. He proved that the property studied by Scarborough and Stone, generalized regular-closed, is not productive. With Vaughan, he proved that for any infinite cardinal κ there exist an initially κ-compact space and weakly initially κ-compact space whose product is not weakly initially κ-compact, and he proved that if κ is a singular cardinal such that $2^\lambda \leq \kappa$ for all $\lambda < \kappa$, then initial κ-compactness is productive, and for such κ, every Tychonoff space X has a smallest initially κ-compact subspace $\kappa(X)$ of $\beta(X)$ such that $X \subseteq \kappa(X)$. With Harley, he proved that an $\mathcal{F}$-space is Lindelöf iff it is $\aleph_1$-compact, a countably compact $\mathcal{F}$-space is compact, and a compact $\mathcal{F}$-space is first countable and hence is a neighborhood $\mathcal{F}$-space. Stephenson proved that there is no universal perfect compact Hausdorff $\mathcal{F}$-space, not every separable compact Hausdorff $\mathcal{F}$-space is hereditarily separable, and a neighborhood $\mathcal{F}$-space is hereditarily Lindelöf iff it is hereditarily separable iff it is perfect and Lindelöf. He proved that a Baire semimetrizable space satisfying the countable chain condition is separable. He proved that for $\mathcal{P}$ = absolutely totally disconnected, every $\mathcal{P}$-space has a $\mathcal{P}$-minimal extension space. With Porter and Woods, he used results of Cameron to prove that a feebly compact space X is maximal feebly compact iff every dense subset of X is an open subset and every feebly compact subspace of X is a closed subset.

The Research Interests of Manfred Stoll

Function Theory, Potential Theory, Several Complex Variables. Research interests include: The study of holomorphic, harmonic, and plurisubharmonic functions of one and several complex variables; H^p spaces, Bergman spaces, Dirichlet spaces, and other spaces of harmonic and holomorphic functions of one and several complex variables; boundary behavior of harmonic functions, subharmonic functions, and Green potentials in domains in R^n and C^n; harmonic function theory on real and complex hyperbolic space.

The Research Interests of David Sumner

My research interests include graph theory and combinatorics. I have written papers dealing with applications to empirical logic, Ramsey Theory, perfect matchings, chromatic number, orientations in graphs, claw-free graphs, Hamiltonian graphs, and most recently the domination number of a graph.

The Research Interests of Li-Yeng Sung

The research interests of Li-yeng Sung are in the field of partial differential equations. They include (1) pseudodifferential operators, (2) multidimensional inverse scattering methods for the N-wave interaction equations, the Davey-Stewartson equations, the Kadomtsev-Petviashvili equations and the Ishimori equations, (3) initial and boundary value problems for dispersive linear and nonlinear integrable equations on the half-line and (4) numerical solutions of partial differential equations.

The Research Interests of Lazslo Szekely

My primary research areas are combinatorics and graph theory, and their applications to computer science and biology. In particular:

- extremal problems (graphs and set systems)
- combinatorial geometry

- graph drawing
- phylogeny reconstruction
- discrete probability
- design and analysis of algorithms
- combinatorial optimization

The primary research areas in more details:

- extremal problems (graphs and set systems): Erdős-Ko-Rado type theorems, Sperner and LYM type theorems, extremal graph theory
- combinatorial geometry: Erdős type problems in geometry, density of sets without certain distances, maximum number of unit distances or minimum number of distinct distances in finite point sets, Szemerédi-Trotter type theorems
- graph drawing: crossing numbers of graphs, applications of crossing numbers of graphs to discrete geometry, graph drawing algorithms on surfaces, books, etc., approximation algorithms for crossing number problems
- phylogeny reconstruction: stochastic models of the evolution of biomolecular sequences, identifiability conditions for reconstructible past, polynomial time algorithms for phylogeny reconstruction, the length of biomolecular sequences necessary for phylogeny reconstruction for all methods and for particular methods, Fourier-Hadamard transform
- discrete probability: stochastic models for biomolecular sequence evolution, derandomization of randomized algorithms for graph drawing
- design and analysis of algorithms: algorithms for graph drawing, approximation algorithms for crossing number problems, algorithms for phylogeny reconstruction
- combinatorial optimization: the multiway cut problem, integral uniform multicommodity flow problem.

Research Interests of Vladimir Temlyakov

My major interests are in Approximation Theory. Approximation theory is a rapidly changing area of mathematics. The core problem of approximation continues to be the development of efficient methods for replacing general functions by simpler functions. Some methods were invented long ago (Fourier sums, Taylor polynomials, best approximations by trigonometric or algebraic polynomials etc.). More recently however, driven by several numerical applications, the directions of approximation theory have moved toward nonlinear and multivariate approximation. This includes the comparatively new subject of nonlinear m-term approximation, wavelets, approximation by ridge functions, bilinear approximation, etc. These have found applications in numerical integration, numerical solution of integral equations, image compression, design of neural networks, and so on. The purpose of my research is to continue the investigations of several areas of multivariate and nonlinear approximation. Emphasis will be placed on nonlinear methods of approximation such as best m-term approximation, metric entropy, and bilinear approximation as well as their interaction with other fields of mathematics and applications. Keeping in mind the applications of nonlinear approximation in numerical analysis we study some nonlinear algorithms of approximation, for instance, "greedy" algorithms.

The Research Interests of Ognian Trifonov

My main research interests are in the area of Analytic Number Theory. In particular I am interested in estimates for the number of lattice points close to a smooth curve. These have many applications, for instance - distribution of squarefull and squarefree numbers in short intervals, the classical Dirichlet divisor problem and the Gauss circle problems. I am also interested in irreducibility of classical polynomials over the field of rational numbers. The technique we use is based on properties of Newton polygons and allowed us to prove that all Bessel polynomials are irreducible over the rationals. This was a hypothesis of Emil Grosswald which was open for more than thirty years.

My secondary research interests are in harmonic analysis and approximation theory and their interaction with number theory. To be more specific, I am interested in number theory problems which stem from signal compression, wavelets, and differential equations.

The Research Interests of Hong Wang

Numerical analysis and differential equations, including numerical approximation to differential/integral equations and scientific computation.

The Research Interests of Xian Wu

My primary field of mathematical interests is algebraic geometry. In particular, I have been working in the areas of Hodge theory and intersection theory. Topics there include normal functions and their infinitesimal invariants, the Noether-Lefschetz theorem, residual intersection decompositions, and etc. I am also interested in applications and connections of algebraic geometry to other fields, such as number theory, cryptography, and mathematical physics.

The theory of the infinitesimal invariant of normal functions was introduced by Griffiths in 1980's. My main interests here is to study the non-degeneracy of the invariant and its applications to geometrical problems, such as the Abel-Jacobi map, Griffiths and Harris' conjecture on curves on threefolds, and Clemens' conjecture on rational curves. Theory of residual intersection also has many applications. For example, I have worked on a refined decomposition formula and it has been used to study such problems as degenerations of hypersurfaces and limiting algebraic cycles, variations of mixed Hodge structures, and the mirror symmetry. The last one is closely related to string theory in mathematical physics and the full extent of the connection is still an active topic of current researches.

Appendix III: The Industrial Mathematics Institute

In 1989 the Department of Mathematics at USC began an Industrial Mathematics Initiative whose primary goal was to foster mathematical research which has an immediate and direct application to the problems of industry and the national laboratories. At its inception, the Initiative had a core research consisting of five faculty, three of whom (Colin Bennett, Ron DeVore, and Robert Sharpley) are still at USC. Initial support for the Initiative was provided by an NSF EPSCOR grant which funded five new faculty positions, a graphics specialist, and a secretary/administrative assistant.

From this meager beginning, the Initiative has blossomed into one of the nation's strongest centers for Applied Mathematics. In 1999, the Initiative was recognized as the Industrial Mathematics Institute (IMI) by the South Carolina Commission on Higher Education (CHE). The IMI, as presently constituted, consists of a Director (Ron DeVore), a Graphics Specialist (Scott Johnson), an Administrative Assistant (Janice Long), and 17 tenured research faculty (Table 1). Several graduate and undergraduate students participate in the research projects of the IMI. The research strength of the IMI is supplemented by its collaborations with premier research centers around the world (Table 2).

TABLE 1. Industrial Mathematics Institute Faculty and Staff

Administration:	Ronald A. DeVore, Director	
	L. Scott Johnson, Graphics Specialist	
	Janice Long, Administrative Coordinator	
Faculty Members:	Colin Bennett	Susanne C. Brenner
	Daniel Dix	Michael Filaseta
	Mohammad Ghomi	Jerrold Griggs
	Ralph Howard	George Johnson
	Douglas Meade	Konstantin Oskolkov
	Pencho Petrushev	Robert C. Sharpley
	Li-yeng Sung	Laszlo Szekely
	Vladimir Temlyakov	Ognian Trifonov
	Hong Wang	

TABLE 2. IMI Research Project Collaborators

AT&T Research (Shannon Laboratory)
Cal Tech (Computer Science)
Moffitt Cancer Center & Research Institute (University of South Florida)
Naval Air Warfare Center (China Lake)
Naval Air Warfare Center (Pax River)
University of Paris VI (Numerical Analysis)
University of Paris VII (Statistics)
Princeton (Applied Mathematics and Chemical Engineering)
Purdue University (Mathematics)
Rice University (Digital Signal Processing)
RWTH (Aachen)
Stanford (Statistics)
Texas A&M University (Institute for Scientific Computing)
University of Wisconsin (Dept. of Computer Science/Dept. of Anatomy)

The IMI is governed by an Executive Committee consisting of six IMI faculty (Table 3). A Scientific Advisory Board (Table 4) consisting of distinguished scientists from the nations premier research facilities.

TABLE 3. IMI Executive Committee

Colin Bennett	Susanne C. Brenner	Jerrold Griggs
Vladimir Temlyakov	Ognian Trifonov	
Ronald DeVore, *ex officio*	Manfred Stoll, *ex officio*	

TABLE 4. IMI Scientific Advisory Board

Stephen Ashby
Director, Center for Applied Scientific Computing, Lawrence Livermore National Laboratory

Robert Calderbank
Director AT&T Labs Research, Florham Park, New Jersey

Richard E. Ewing
Director, Institute for Scientific Computation; Director, Academy for Advanced Telecommunications & Learning Technologies; Director, Science and Technology Division, Texas Engineering Experiment Station; Mathematics, Applied Mathematics and Engineering, Texas A&M University

Ridgway Scott
Co–Director, Argonne/Chicago Computation Institute; Computer Science and Mathematics, University of Chicago

Gilbert Strang
President, Society of Industrial and Applied Mathematics, 1999; Mathematics, Massachusetts Institute of Technology

Eitan Tadmor
NSF Institute for Pure and Applied Mathematics, UCLA

The IMI has a distinguished lecture series in which outstanding mathematical scientists doing research in application areas of interest to the IMI present their research. The IMI preprint series is made readily available to the research community through the IMI website located at

`http://www.math.sc.edu/~IMI`

Recent highlights of the Institute's accomplishments and continuing recognition include:

- Total active research funding of $3,794,793 in April 2000
- Research funding in telecommunications exceeding $2.44 million in 1999
- The nation's largest NSF KDI grant in the inceptual 1998 competition
- Collaborations with leading national and international centers for Applied Mathematics
- Research projects with several industrial partners and national laboratories

The Research Programs of the IMI.

The research interests of the IMI spread across a wide spectrum of mathematics and its applications. The following is a very brief summary of these research areas:

Telecommunication and Information Technology. Telecommunication and information are the heart of the nation's infrastructure for the collection, storage, transmission, and analysis of data such as satellite and medical imagery. They support critical application areas such as internet traffic, distance learning, wireless communication, military planning, surveillance and intelligence, autonomous navigation, and medical diagnostics. The IMI is a leading center for the development of multiscale methods in telecommunication and data representations. This includes state of the art wavelet based methods for image and signal compression, denoising, registration, feature extraction, and target recognition. The core research faculty in this area (Colin Bennett, Ron DeVore, Konstantin Oskolkov, Pencho Petrushev, Robert Sharpley, and Vladimir

Temlyakov) are internationally recognized for their development of mathematical techniques in multiresolution analysis and nonlinear approximation. These two research disciplines are at the core of state of the art image and signal processing. The IMI collaborates with several of the world's foremost research institutions in telecommunication including AT&T Research at Florham Park (Wireless Communication), Cal Tech (Computer Science: Visualization and Computer Aided Design), National Air Warfare Center at China Lake (target acquisition), University of Paris VI (Numerical Analysis and Statistics: image processing and statistical estimation), Princeton University (Computer Science and Mathematics: signal processing and A/D conversion), Stanford University (Statistics: image processing and statistical estimation), the University of Wisconsin (Computer Science and Dept. of Anatomy: medical imagery), and Lawrence Livermore National Laboratory (Center for Advanced Scientific Computing: large scale computation, visualization, and data mining).

Analytical and Numerical Methods for Partial Differential Equations. Partial Differential Equations (PDEs) model important physical phenomena such as geophysical applications in seismic simulation and analysis for fossil fuels exploration, weather forecasting, multiphase groundwater flow and contaminant transport in unsaturated porous media, and enhanced oil recovery. These equations are typically tightly coupled systems of nonlinear partial differential equations describing basic continuum principles, constituency equations, and biological or chemical reaction equations. Analogous equations arise in simulations studies for material science, structural mechanics, population dynamics and epidemiology, and are current areas of interest of IMI faculty.

These equations cannot be solved exactly (except in extremely simple cases) and sophisticated numerical methods must developed to resolve them accurately using computers. The size of these computational problems challenges the largest supercomputers and computational facilities in existence. The core research faculty (Susanne Brenner, Ron DeVore, Robert Sharpley, Li-Yeng Sung, and Hong Wang) analyze and develop computational methods for numerically resolving systems of partial differential equations. Their main emphasis has been on multiscale methods (multigrid and wavelet based) and adaptive techniques which allow the analysis of local phenomena and lead to accurate, efficient, and scalable (i.e., in essence, perfectly parallelizable) algorithms. The IMI together with Oak Ridge National Laboratory, Brookhaven National Laboratory, SUNY (Stony Brook), Princeton, Rice, and Texas A&M in the early 1990's formed the Partnership in Computational Science (PICS) to demonstrate the feasibility of developing massively parallel capabilities to approach targeted problem of high national interest. This DOE sponsored consortium addressed the President's "Computational Grand Challenge" to develop large scale computational tools directed toward contaminant transport and groundwater modeling to assist in environmental impact assessments and remediation efforts at heavily contaminated sites. The IMI also has current collaborative efforts with Mobil Oil Company to develop large scale computational methods for enhanced reservoir simulation.

Visiting and Postdoctoral Program.

The IMI hosts one of the nation's most intense visitor and postdoctoral research programs. Approximately fifty scientists visit the IMI each year. These scientists come from the world's most prestigious research centers and provide an important resource for the research and educational programs of the IMI. Typically, five or six postdoctoral associates are in residence at any given time at the IMI (see Table 5).All of these postdoctoral appointments are supported by research grants and enhance the various research projects of the IMI.

TABLE 5
IMI Postdoctoral Researchers 2000–2001

Peter Binev	Remi Gribonval	Morten Nielson
Alexander Petukhov	Jung Ho Yoon	

IMI Postdoctoral Researchers 2001–2002

Peter Binev	Borislav Karaivanov	Morten Nielson
Alexander Petukhov	John Lane	

Educational Impact of the IMI.

The IMI offers no formal degree programs. However, graduate and undergraduate students participate in several of the research projects of the IMI. An example is provided by the research team studying the compression and visualization of Digital Terrain Elevation Data (DTED) which is made up of three research faculty (Ron DeVore, Pencho Petrushev, and Robert Sharpley), one postdoctoral associate (Peter Binev), IMI's graphics specialist (Scott Johnson), six graduate students (John Lane, Angel Koumchev, Borislav Karaivanov, Roumen Kozarev, Kyungwon Park, and Vesco Vatchev), and two undergraduate honors students (Woody Folsom and Jonathan Mason). Each summer we typically employ 3-4 undergraduates and 8-10 graduate students to assist us on our projects. Many of these students are employed during the academic year.

Participation in cutting edge research programs provides exposure for these students to important applications of mathematics and some of the most sophisticated mathematical tools such as wavelet decompositions, nonlinear approximation, multigrid methods, and nonlinear evolution equations. Graduates with this type of training are in high demand for jobs in industry and academia.

Computational Facilities.

IMI's research projects are being carried out utilizing computational facilities primarily located in the Industrial Mathematical Institute's Image Processing and Computational Laboratory which is located in LeConte College, Room 419. The laboratory is a limited access facility for IMI researchers, students and support staff. A DOD DURIP grant, which was awarded in April 1998, upgraded the laboratory with the addition of two Silicon Graphics Octane II's (each with dual processors, high end graphics subsystems and texture buffers), three Silicon Graphics O2's, and an SGI server with a 90 GigaByte storage 'vault'. This added to the previous equipment of three Silicon Graphics Indigo II's, special graphics hardware and software including compression boards, video tape deck editor, color printers, video camera, stereo eyeglasses, read/writeable CD-Rom storage, slide scanner, color printing, and a two multipurpose Pentium II's which were obtained through a 1993 DURIP award and university cost share.

The equipment portion of USC's component of the PICS project was a 56 node Intel Paragon which was used as a parallel development machine for applications which were later migrated to the several thousand node production version at ORNL. IMI personnel maintained and operated this machine at USC over a period of 8 years, making its computational resources available to the university community at large, as well as other universities in the state. The Paragon has since been merged with other PICS consortium machines and is housed at Texas A&M University. Access to this equipment from the IMI laboratory is via a vBNS connection which was funded through an NSF grant of which IMI faculty DeVore and Sharpley were co-PI's.

In August 2000, IMI faculty were awarded an NSF SCREMS grant (matched by the college, department, and IMI) to further enhance the computational and imaging facilities of the IMI. This grant provides a multiprocessor Beowulf system to continue algorithm development research on advanced computational architectures, two FakeSpace Systems (goggle-less) stereo monitors to continue IMI's 3D visualization work, and a high performance engine for heavy serial computations. IMI has also applied to the DURIP program for a FakeSpace Systems immersive environment PowerWall display.

Appendix IV: The Curricula in Mathematics

The Undergraduate Curriculum in Mathematics

To qualify for a Bachelor of Science degree in Mathematics, a student must complete 128 credit hours of course work which must satisfy the following requirements:

The University's Core Requirements

Group I: Competency Group

The student must pass English 101 and 102, two one-hundred level history courses (at least one must be other than a U.S. history course), and satisfy the Foreign Language requirement (a proficiency requirement at the level of the exit examination at the 122 level). Students may exempt an part of these requirements by advanced placement.

Group II: Quantitative Group

Mathematics majors must pass the three semester of calculus sequence, MATH 141, MATH 142, and MATH 241, with grades of C or better. They must also pass the computer science course CSCE 145.

Group III: Humanities Group

Each student must pass at lest 6 additional hours of student in the humanities, at lest one course must be in fine arts history (art, music, theater).

Group IV: Social Sciences

Each student must pass at least 6 additional hours of student in the social and behavioral sciences.

Group V: Laboratory Sciences

Each student must pass at least 8 credit hours in laboratory science courses. Both of these courses must include a laboratory experience.

Cognates and Minors

Each student is required to pass twelve credit hours of upper level coursework from outside the major discipline. The cognate is designed to support the major and must be approved by the major advisor. A student may elect to complete a minor rather than a cognate. The minor consists of 16–18 credit hours, which form a second area of competency. All courses in the minor must be passed with grades of C or better.

Mathematics Major Requirements

There are five program options in Mathematics, each leading to the Bachelor of Science degree.

General Mathematics Major

MATH 520, 544 (or 526), 546, 554, 574, plus three approved MATH electives numbered above 500, to include at least one of MATH 534, 550, 552 (24–25 hours).

Applied Mathematics Major

MATH 520, 524, 526, 546, 554, 570 or 527, 574, plus one elective chosen from MATH 521, 527, 550, 552, 570, 575 (25 hours).

Actuarial Mathematics Major

(a) MATH 511, 520, 526 (or 544), 546, 554, 574, 570 (or 524), plus 3 hours in Mathematics at 500 level (24 – 25 hours).

(b) A minimum of 24 hours in Business Administration and Statistics as follows.
(i) Statistics (6 – 12 hours): STAT 512, 513, and 0 - 6 hours from STAT 510, 520(=MGSC 520).
(ii) Business Administration (12 – 18 hours): ACCT 222, ECON 224, FINA 363 (=ECON 363), FINA 341 or 444, and 0 - 6 hours from FINA 342, 346, 443, 444, 445, MGSC 392, 393, 520 (=STAT 520), 594, ECON 420, 594, BADM 499. For the Minor in Risk Management & Insurance (18 hours), of the additional 6 hours, an additional three hours must be chosen from FINA 342, 443, 444, or 445.

(c) Computing (7 – 8 hours) : CSCE 145, plus one elective from CSCE 146, MGSC 390, STAT 517.

Mathematics Education Major (For majors interested in pursuing the MT degree in Education)

MATH 520, 544 (or 526), 546, 554, 574, 580, 531 or 532, plus 3 additional hours chosen from 511, 531, 532, 550, 552 (24 – 25 hours). For the Cognate, students must take the required EDUC courses in the College of Education.

Intensive Major

Any major above, plus an additional four approved MATH electives number above 500 (36–37 hours).

Every mathematics major is also required to complete one of the following sequences:

1. STAT 511 (=MATH 511) and STAT 512
2. either STAT 509 or STAT 515 and either STAT 516 or CSCE 146.

Cognate or Minor for Nonmajors

Students with majors in other departments may effectively supplement their major program of study by selecting a cognate or minor in mathematics,

Cognate in Mathematics. Most courses in mathematics numbered 241 and above may be used for cognate credit.

Minor in Mathematics. The minor consists of MATH 241 together with at least 15 hours of mathematics courses selected from MATH 242 or 500–level MATH courses. At least six of the 15 hours must be chosen from MATH 520, 526, 544, 546, 554, 574. At most one of MATH 526, 544 may be used for minor credit.

Minor in Actuarial Mathematics and Statistics. The minor consists of the prerequisites courses MATH 141, 142, 241 plus 18 hours of mathematics and statistics courses chosen as follows: MATH 511 [=STAT 511], STAT 512, 513, one of STAT 510, 520, one of MATH 526, 544, and one of MATH 570, 574.

Frequency of Course Offerings and Program Changes

All required courses, indeed almost all the courses mentioned explicitly above, are offered every semester. Systematic efforts to improve calculus instruction have had a number of consequences

- In the early 1990's the Calculus Workshops (MATH 151 and 152) were introduced in connection with the NSF funded South Carolina Alliance for Minority Participation in the Sciences and Engineering.
- The main calculus sequence is now offered in two formats: the traditional lecture/recitation format (with lectures of size 60) and a format in which calculus is taught by traditional methods to classes of size about 30 meeting four hours a week. Calculus was also taught using a reform approach for a number of years. The Spring 2003 semester will see several pilot sections of first calculus incorporating a Maple Lab.
- Our calculus course for students of business and the social sciences (MATH 122) has been thoroughly reformed along the lines of the Harvard approach.

These efforts to improve our instructional programs grew out of interdisciplinary discussions among the faculty of various colleges. Other interdisciplinary courses, for example a mathematics course offered to Honors College students of biology, have also been devised.

Undergraduate Mathematics Course Descriptions

111–Basic College Mathematics. (3): (Prereq: qualification through placement or a grade of C or better in MATH 100) Basic college algebra; linear and quadratic equations, inequalities, functions and graphs of functions, exponential and logarithm functions, systems of equations. Credit may not be received for both MATH 111 and 115.

112–Trigonometry. (2) : (Prereq: qualification through placement or a grade of C or better in MATH 111) Topics in trigonometry specifically needed for MATH 141, 142, 241. Circular functions, analytic trigonometry, applications of trigonometry. Credit may not be received for both MATH 112 and 115.

115–Precalculus Mathematics. (4) : (Prereq: qualification through placement) Topics in algebra and trigonometry specifically needed for MATH 141, 142, 241. Subsets of the real line, absolute value; polynomial, rational, inverse, logarithmic, exponential functions; circular functions; analytic trigonometry. Credit may not be received for both MATH 111 and 115 or both MATH 112 and 115.

122–Calculus for Business Administration and Social Sciences. (3): (Prereq: qualification by placement or a grade of C or better in MATH 111 or 115) Derivatives and integrals of elementary algebraic, exponential, and logarithmic functions. Maxima, minima, rate of change, motion, work, area under a curve, and volume.

141–Calculus I. (4) : (Prereq: qualification through placement or a grade of C or better in MATH 112 or 115) Limits, continuity; derivatives, chain rule, rates of change, curve sketching, max-min problems; definite integral, antiderivatives, and the Fundamental Theorem.

142–Calculus II. (4) : (Prereq: qualification through placement or a grade of C or better in MATH 141) Techniques of integration, exponential, and inverse trigonometric functions; numerical methods, and applications of the integral; sequences, power and Taylor series.

151–Calculus Workshop I. (2) : (Coreq: MATH 141) Small study group practice in applications of calculus. For elective credit only. Two 2-hour sessions per week.

152–Calculus Workshop II. (2) : (Coreq: MATH 142) Small study group practice in applications of calculus. For elective credit only. Two 2-hour sessions per week.

170–Finite Mathematics. (3) : (Prereq: qualification through placement or a grade of C or better in MATH 111 or 115) Elementary matrix theory; systems of linear equations; permutations and combinations; probability and Markov chains; linear programming and game theory.

172–Mathematical Modeling for the Life Sciences. (3) : Modeling with difference equations; vectors, trigonometry, polar coodinates, matrices, eigenvalues and eigenvectors; addition and multiplication in combinatorics, permutations, combinations, introduction to probability theory (discrete, continuous); techniques of integration, symmetry. Credit may not be received for both MATH 172 and either MATH 170 or 174.

174–Discrete Mathematics for Computer Science. (3) : (Prereq: qualification through placement or a grade of C] or better in MATH 112 or 115) Induction, complexity, elementary counting, combinations and permutations, recursion and recurrence relations, graphs and trees; discussion of the design and analysis of algorithms with emphasis on sorting and searching.

221–Basic Concepts of Elementary Mathematics I. (3): (Prereq: qualification through placement or a grade of C or better in MATH 111 or 115) The meaning of number, fundamental operations of arithmetic, the structure of the real number system and its subsystems, elementary number theory. Open only to students in elementary or early childhood teacher certification.

222–Basic Concepts of Elementary Mathematics II. (3) : (Prereq: MATH 221) Informal geometry and basic concepts of algebra. Open only to students in elementary or early childhood teacher certification.

241–Vector Calculus. (3) : (Prereq: qualification through placement or a grade of C or better in MATH 142) Vector algebra, geometry of three-dimensional space; lines, planes, and curves in space; polar, cylindrical, and spherical coordinate systems; partial differentiation, max-min theory; multiple and iterated integration, line integrals, and Green's theorem in the plane.

242–Elementary Differential Equations. (3) : (Prereq: qualification through placement or a grade of C or better in MATH 142) Ordinary differential equations of first order, higher order linear equations, Laplace transform methods, series methods; numerical solution of differential equations. Applications to physical sciences and engineering. Introduction to programming desirable.

399–Independent Study. (3-9) : Contract approved by instructor, advisor, and department chair is required for undergraduate students.

401–Conceptual History of Mathematics. (3) : (Prereq: MATH 122, or 141, or consent of the department) Topics from the history of mathematics emphasizing the seventeenth century to the present. Various mathematical concepts are discussed and their development traced. For elective or Group II credit only.

511–Probability. [= STAT 511] (3) : (Prereq: MATH 241 with a grade of C or higher) Probability and independence; discrete and continuous random variables; joint, marginal, and conditional densities, moment generating function; laws of large numbers; binomial, Poisson, gamma, univariate, and bivariate normal distributions.

520–Ordinary Differential Equations. (3) : (Prereq: MATH 544 or 526; or consent of department) Differential equations of the first order, linear systems of ordinary differential equations, elementary qualitative properties of nonlinear systems.

521–Boundary Value Problems and Partial Differential Equations. (3): (Prereq: MATH 520 or 241 and 242) Laplace transforms, two-point boundary value problems and Green's functions, boundary value problems in partial differential equations, eigenfunction expansions and separation of variables, transform methods for solving PDE's, Green's functions for PDE's, and the method of characteristics.

524–Nonlinear Optimization. (3) : (Prereq: MATH 526 or 544 or consent of department) Descent methods, conjugate direction methods, and Quasi-Newton algorithms for unconstrained optimization; globally convergent hybrid algorithm; primal, penalty, and barrier methods for constrained optimization. Computer implementation of algorithms.

525–Mathematical Game Theory. (3) : (Prereq: MATH 526 or 544) Two-person zero-sum games, minimax theorem, utility theory, n-person games, market games, stability.

526–Numerical Linear Algebra. (4) : (Prereq: MATH 241) Matrix algebra, Gauss elimination, iterative methods; overdetermined systems and least squares; eigenvalues, eigenvectors; numerical software. Computer implementation. Three lectures and one laboratory hour per week. Credit may not be received for both MATH 526 and MATH 544.

527–Numerical Analysis. [= CSCE 561] (3) : (Prereq: MATH 242 or 520; or consent of department) Interpolation and approximation of functions, solution of algebraic equations, numerical differentiation and integration; solution of ordinary differential equations and boundary value problems. Computer implementation of algorithms.

531–Foundations of Geometry. (3): (Prereq: MATH 241) The study of geometry as a logical system based upon postulates and undefined terms. The fundamental concepts and relations of Euclidean geometry developed rigorously on the basis of a set of postulates. Some topics from non-Euclidean geometry.

532–Modern Geometry. (3) : (Prereq: MATH 241) Projective geometry, theorem of Desargues, conics, transformation theory, affine geometry, Euclidean geometry, non-Euclidean geometries, and topology.

533–Elementary Geometric Topology. (3) : (Prereq: MATH 241) Topology of the line, plane, and space, Jordan curve theorem, Brouwer fixed point theorem, Euler characteristic of polyhedra, orientable and non-orientable surfaces, classification of surfaces, network topology.

534–Elements of General Topology. (3) : (Prereq: MATH 241) Elementary properties of sets, functions, spaces, maps, separation axioms, compactness, completeness, convergence, connectedness, path connectedness, embedding and extension theorems, metric spaces, and compactification.

540–Modern Applied Algebra. (3) : (Prereq: MATH 241) Finite structures useful in applied areas. Binary relations, Boolean algebras, applications to optimization, and realization of finite state machines.

541–Algebraic Coding Theory. (3) : (Prereq: MATH 526 or MATH 544 or consent of department) Error-correcting codes, polynomial rings, cyclic codes, finite fields, BCH codes.

544–Linear Algebra. (3) : (Prereq: MATH 241) Matrix algebra, solution of linear systems; notions of vector space, independence, basis, dimension; linear transformations, change of basis; eigenvalues, eigenvectors, Hermitian matrices, diagonalization; Cayley-Hamilton theorem. Credit may not be received for both MATH 526 and MATH 544.

546–Algebraic Structures I. (3) : (Prereq: MATH 241) Permutation groups; abstract groups; introduction to algebraic structures through study of subgroups, quotient groups, homomorphisms, isomorphisms, direct product; decompositions; introduction to rings and fields.

547–Algebraic Structures II. (3) : (Prereq: MATH 546) Rings, ideals, polynomial rings, unique factorization domains; structure of finite groups; topics from: fields, field extensions, Euclidean constructions, modules over principal ideal domains (canonical forms).

550–Vector Analysis. (3) : (Prereq: MATH 241) Vector fields, line and path integrals, orientation and parameterization of lines and surfaces, change of variables and Jacobians, oriented surface integrals, theorems of Green, Gauss, and Stokes; introduction to tensor analysis.

551–Introduction to Differential Geometry. (3) : (Prereq: MATH 241) Parameterized curves, regular curves and surfaces, change of parameters, tangent planes, the differential of a map, the Gauss map, first and second fundamental forms, vector fields, geodesics, and the exponential map.

552–Applied Complex Variables. (3): (Prereq: MATH 241) Complex integration, calculus of residues, conformal mapping, Taylor and Laurent Series expansions, applications.

554–Analysis I. (3) : (Prereq: MATH 241) Least upper bound axiom, the real numbers, compactness, sequences, continuity, uniform continuity, differentiation, Riemann integral and fundamental theorem of calculus.

555–Analysis II. (3) : (Prereq: MATH 554 or consent of department) Riemann-Stieltjes integral, infinite series of functions, uniform convergence, Weierstrass approximation theorem, selected topics from Fourier series or Lebesgue integration.

561–Introduction to Mathematical Logic. (3) : (Prereq: MATH 241) Syntax and semantics of formal languages; sentential logic, proofs in first order logic; Gödel's completeness theorem; compactness theorem and applications; cardinals and ordinals; the Löwenheim-Skolem-Tarski theorem; Beth's definability theorem; effectively computable functions; Gödel's incompleteness theorem; undecidable theories.

562–Theory of Computation. [= **CSCE 551**] **(3):** (Prereq: CSCE 213 and CSCE 330, or MATH 526, or MATH 544, or MATH 574) Basic theoretical principles of computer science as modeled by formal languages and automata; computability and computational complexity.

570–Discrete Optimization. (3) : (Prereq: MATH 526 or 544) Discrete mathematical models. Applications to such problems as resource allocation and transportation. Topics include linear programming, integer programming, network analysis, and dynamic programming.

574–Discrete Mathematics I. (3) : (Prereq: MATH 142) Mathematical models; mathematical reasoning; enumeration; induction and recursion; tree structures; networks and graphs; analysis of algorithms.

575–Discrete Mathematics II. (3) : (Prereq: MATH 574) A continuation of MATH 574. Inversion formulas; Polya counting; combinatorial designs; minimax theorems; probabilistic methods; Ramsey theory; other topics.

576–Combinatorial Game Theory. (3) : (Prereq: MATH 526, 544, or 574) Winning in certain combinatorial games such as Nim, Hackenbush, and Domineering. Equalities and inequalities among games, Sprague-Grundy theory of impartial games, games which are numbers.

580–Elementary Number Theory. (3) : (Prereq: MATH 241) Divisibility, primes, congruences, quadratic residues, numerical functions. Diophantine equations.

599–Topics in Mathematics. (1-3) : Recent developments in pure and applied mathematics selected to meet current faculty and student interest.

650–AP Calculus for Teachers. (3) : (Prereq: current secondary high school teacher certification in mathematics and at least six hours of calculus) A thorough study of the topics to be presented in AP calculus, including limits of functions, differentiation, integration, infinite series, and applications. (Not intended for degree programs in mathematics.)

The Graduate Curriculum in Mathematics

Doctor of Philosophy Degree

The Ph.D. in mathematics is designed to produce a skilled professional mathematician who is trained to conduct research in mathematics, function effectively as a classroom teacher at the college level, or become a professional practitioner in an industrial setting. Each candidate for the Ph.D. degree is required to complete 12 semester hours of graduate course work separate from the course work covered by the Admission to Candidacy and Comprehensive Examinations (see below). These 12 hours are in addition to directed reading courses. The student's doctoral committee decides which courses are appropriate to fulfill this requirement. In addition, the Ph.D. candidate is required to take three semester hours of the doctoral seminar MATH 890, the content of which must include research. Students may earn these doctoral seminar credits by taking and participating in a seminar in their research area. Demonstrated reading proficiency is also required in one of the following foreign languages: French, German, or Russian. In addition, the student must show proficiency in a computer programming language.

Students pursuing the Ph.D. degree in mathematics are required to take three examinations: the Admission to Candidacy Examination, the Comprehensive Examination, and the Dissertation Examination.

The admission to Candidacy Examination in Mathematics is administered in two versions. The first version consists of two three-hour written examinations, each of which is based primarily (but not exclusively) on the subject matter of the two one-year sequences in algebra (MATH 700, 701) and analysis (MATH 703, 704). The second version consists of two three-hour written examinations, each of which is based primarily (but not exclusively) on the subject matter of the two one-year sequences in linear and numerical linear algebra (MATH 700, 706) and analysis (MATH 703, 704). Two attempts of the Admission to Candidacy Examination are allowed. The first attempt should occur after the first year of graduate study and within the first two years of graduate study. The second attempt must be made at the next scheduled examination. Exceptions to the time constraint for unusual cases may be petitioned to the Graduate Advisory Council.

The Comprehensive Examination for the Ph.D. in mathematics is an in-depth examination consisting of a written exam administered in three, three to four hour sessions, and an oral examination. The contents of the written portion of the examination must include the subject matter of two or three one-year sequences numbered 710 or higher from two of the eight areas listed below and also test in-depth the subject matter of the student's research area. The oral portion of the Comprehensive Examination will be based on the student's program of study and may include topics not covered by either the Admission to Candidacy Examination or the written portion of the Comprehensive Examination.

The student's research specialization for the Comprehensive Examination should be selected from one of the following areas:

- algebra
- analysis
- applied mathematics
- discrete mathematics
- geometry
- logic
- number theory
- topology

The Comprehensive Examination may be repeated only once. All portions of the examination must be completed within three weeks. As a general rule, the exam is offered twice each year, once in August and again in January, and should be taken after candidates have completed all courses required in their program. In special cases, the examination may be scheduled any time during the year with permission from the examination committee. The examination must be completed at least 60 days prior to the date in which the student expects to receive the degree.

To complete the program, the student must write a dissertation (to be bound and placed in the University library and in the department) under the direction of a member of the graduate faculty, and defend the content of the dissertation in a final examination before the doctoral committee. It is expected that the content of the student's dissertation will be a significant contribution to the body of current research and will be published in a reputable journal.

To ensure diversity in the student's program, each student is required to satisfactorily complete ("B" or better) 12 semester hours of course work in subject areas not covered by the Admission to Candidacy and Comprehensive Examination. Students who take the Admission to Candidacy Examination based on Math 700, 706 will be required to complete the course Math 701 as part of this twelve hour requirement, but no later than one year after passing the Comprehensive Examination. Additional course requirements may be stipulated by the student's doctoral committee. The Graduate School requires a doctoral candidate to register for at least 12 hours of dissertation (MATH 899) during the research portion of the program.

The Master of Arts Degree in Mathematics

The M.A. in mathematics is designed primarily for students who wish to enter the Ph.D. program in mathematics. A student's program of study for this degree is usually narrow in scope but intense in content. Course work for the degree is generally regarded as preparatory for the Ph.D.

The M.A. degree requires a master's pass on the Admission to Candidacy Examination as well as a thesis and 30 approved semester hours of graduate mathematics course work, including MATH 790 and the three credit thesis course, MATH 799. All courses in the student's program must be numbered 700 and above, and must include a one-year sequence in linear algebra/algebra (MATH 700, and one of 701, 706), and the analysis sequence (MATH 703, 704). These courses form the core of the student's program and provide the topics upon which the master's examination is based.

The thesis for this degree is generally a short monograph (to be bound and placed in the University library and in the department), the content of which is drawn from several current research paper s (possibly including the student's original contributions) in an area of interest to the student, which could lead to topics and issues of suitable depth for a Ph.D. dissertation. Upon conclusion of the program, the student is invited to present the thesis to the department in a colloquium address.

The Master of Science Degree in Mathematics

The M.S. in mathematics is designed primarily for students who seek broad and intensive preparation for teaching in a junior college or working in industry.

The M.S. degree requires a thesis and 30 approved semester hours of graduate course work, including satisfactory completion of MATH 700 and 703, the three semester hour thesis course MATH 799, and MATH 790. MATH 790 is a one-semester-hour seminar designed for first-year graduate students. The courses in the student's program should be numbered above 699. However, in special circumstances, some 500-level courses may be approved for a student's program if the courses supplement 700-level course work. In general, a student's M.S. program should be fairly broad in scope and should include courses of both pure and applied nature.

The thesis for this degree is generally a short monograph (to be bound and placed in the University library and in the department), the content of which is drawn from several research papers in an area of interest to the student.

Upon conclusion of the program, each M.S. degree candidate either undergoes an oral examination (which includes an oral presentation of the thesis) administered by a committee chaired by the student's thesis advisor, or obtains a master's pass on the Ph.D. Admission to Candidacy Examination. Students who earn a master's pass are invited to present the thesis in a colloquium address to the Department.

The Department offers two degrees for students who wish to pursue graduate programs emphasizing secondary mathematics education:

The Master of Mathematics Degree

The Master of Mathematics degree is designed primarily for students who seek a broad, thorough training in mathematics which includes course work specifically designed to meet the needs of secondary school teachers.

The M.M. degree requires 30 approved semester hours of graduate course work, up to six hours of which may be outside the Departments of Mathematics, Computer Science, and Statistics. A core of four courses is required of all students: MATH 701-I Foundations of Algebra I, MATH 702-I Foundations of Algebra II, MATH 703-I Foundations of Analysis, and MATH 704-I Foundations of Analysis II.

In addition, each student must include in their program (if similar courses have not been taken previously), a course in geometry chosen from MATH 531, MATH 532, or MATH 736-I) and a course in linear algebra (MATH 526 or MATH 544). To ensure breadth in the program of study, the remaining course work should include courses in probability and statistics and computer science.

Each candidate for the M.M. degree is required to pass a written Comprehensive Examination which is based primarily on the four core courses. The examination will consist of two, two to three hour written examinations which will be offered by the department three times each year, in May, August, and December. Students should take the Comprehensive Examination immediately upon completion of the core courses. Foreign language proficiency is not required.

The Master of Arts in Teaching Mathematics

The M.A.T. in mathematics is offered by the Department of Mathematics jointly with the University's College of Education. This degree program is designed specifically for students who wish to obtain certification in mathematics at the secondary level.

The M.A.T. degree requires 30 approved semester hours of graduate-level course work in mathematics and education (exclusive of student teaching). The individual student's program is planned according to that student's background and goals. At least half of the student's course work must be numbered 700 or higher.

Each student's program of study must include a course in geometry (one from MATH 531, 532, 736-I), algebraic structures (MATH 546 or 701-I), analysis (MATH 554 or 703-I), probability and statistics (MATH 712-I or STAT 509), and two approved math electives at the 500 or 700 level. If similar courses have already been taken, appropriate substitutions will be made.

Unless previously taken, the student must also take a course in linear algebra (MATH 526 or 544), a course in discrete mathematics (MATH 574), and a course in computer science using a high-level programming language (CSCE 500 or CSCE145).¡p¿Course work in education must include Human Growth and Development (EDPY 705), The School in Modern society (EDFN 749), a teaching skills course (EDSE 770 or 783), and an Advanced Methods of Teaching Mathematics course (EDSE 764).

The student must also complete an undergraduate mathematics methods course (EDSE 550), a course in the teaching of reading (EDRD 518 or 730) and a program of directed teaching in mathematics (EDSE 778A and EDSE 778B) which is administered through the College of Education. Students must apply for admission to directed teaching through the College of Education's Office of Field Experience early in the fall or spring semester prior to the semester of directed teaching.

Upon admission to the M.A.T. program, the student is assigned a faculty advisor in mathematics to assist in the development of the mathematics portion of the program. Approval of the candidate's program will be granted by a committee of three faculty members, consisting of the faculty advisor in mathematics, the faculty advisor in education, and a faculty member from either mathematics or education.

Each student must maintain a"B" average on all graduate level course work in mathematics and a "B" average on all graduate level course work in education.

Candidates for the M.A.T. degree are required to pass a written Comprehensive Examination covering their program of study and emphasizing calculus, algebra (MATH 546 or 701-I), and analysis (MATH 554 or 703-I). This examination is offered three times per year through the College of Education Examination Program administered by its Office of Student Services. Students must apply to take the examination three weeks prior to the administration date. The M.A.T. requires neither a foreign language nor a thesis.

Graduate Mathematics Course Descriptions

511–Probability. [= STAT 511] (3): (Prereq: MATH 241 with a grade of C or higher) Probability and independence; discrete and continuous random variables; joint, marginal, and conditional densities, moment generating functions; laws of large numbers; binomial, Poisson, gamma, univariate, and bivariate normal distributions.

520–Ordinary Differential Equations. (3): (Prereq: MATH 544 or 526; or consent of department) Differential equations of the first order, linear systems of ordinary differential equations, elementary qualitative properties of nonlinear systems.

521–Boundary Value Problems and Partial Differential Equations. (3): (Prereq: MATH 520, or 241 and 242) Laplace transforms, two-point boundary value problems and Green's functions, boundary value problems in partial differential equations, eigenfunction expansions and separation of variables, transform methods for solving PDE's, Green's functions for PDE's, and the method of characteristics.

524–Nonlinear Optimization. (3): (Prereq: MATH 526 or 544 or consent of department) Descent methods, conjugate direction methods, and Quasi-Newton algorithms for unconstrained optimization; globally convergent hybrid algorithm; primal, penalty, and barrier methods for constrained optimization. Computer implementation of algorithms.

525–Mathematical Game Theory. (3): (Prereq: MATH 526 or 544) Two person zero-sum games, Minimax theorem, utility theory, n-person games, market games, stability.

526–Numerical Linear Algebra. (4): (Prereq: MATH 241) Matrix algebra, Gauss elimination, iterative methods; overdetermined systems and least squares; eigenvalues, eigenvectors; numerical software. Computer implementation. Three lectures and one laboratory hour per week. Credit may not be received for both MATH 526 and MATH 544.

527–Numerical Analysis. [= CSCE 561] (3): (Prereq: MATH 242 or 520; or consent of department) Interpolation and approximation of functions, solution of algebraic equations, numerical differentiation and integration; solution of ordinary differential equations and boundary value problems. Computer implementation of algorithms.

531–Foundations of Geometry. (3) : (Prereq: MATH 241) The study of geometry as a logical system based upon postulates and undefined terms. The fundamental concepts and relations of Euclidean geometry developed rigorously on the basis of a set of postulates. Some topics from non-Euclidean geometry.

532–Modern Geometry. (3): (Prereq: MATH 241) Projective geometry, theorem of Desargues, conics, transformation theory, affine geometry, Euclidean geometry, non-Euclidean geometries, and topology.

533–Elementary Geometric Topology. (3) : (Prereq: MATH 241) Topology of the line, plane and space, Jordan curve theorem, Brouwer fixed point theorem, Euler characteristic of polyhedra, orientable and non-orientable surfaces, classification of surfaces, network topology.

534–Elements of General Topology. (3): (Prereq: MATH 241) Elementary properties of sets, functions, spaces, maps, separation axioms, compactness,completeness, convergence, connectedness, path connectedness, embedding and extension theorems, metric spaces, and compactification.

540–Modern Applied Algebra. (3): (Prereq: MATH 241) Finite structures useful in applied areas. Binary relations, Boolean algebras, applications to optimization, and realization of finite state machines.

541–Algebraic Coding Theory. (3): (Prereq: MATH 526 or MATH 544 or consent of instructor) Error correcting codes, polynomial rings, cyclic codes; finite fields, BCH codes.

544–Linear Algebra. (3) : (Prereq: MATH 241) Matrix algebra, solution of linear systems; notions of vector space, independence, basis, dimension; linear transformations, change of basis; eigenvalues, eigenvectors, Hermitian matrices, diagonalization; Cayley-Hamilton theorem. Credit may not be received for both MATH 526 and MATH 544.

546–Algebraic Structures I. (3) : (Prereq: MATH 241) Permutation groups; abstract groups; introduction to algebraic structures through study of subgroups, quotient groups, homomorphisms, isomorphisms, direct product; decompositions; introduction to rings and fields.

547–Algebraic Structures II. (3) : (Prereq: MATH 546) Rings, ideals, polynomial rings, unique factorization domains; structure of finite groups; topics from: fields, field extensions, Euclidean constructions, modules over principal ideal domains (canonical forms).

550–Vector Analysis. (3) : (Prereq: MATH 241) Vector fields, line and path integrals, orientation and parameterization of lines and surfaces,change of variables and Jacobians, oriented surface integrals, theorems of Green, Gauss, and Stokes; introduction to tensor analysis.

551–Introduction to Differential Geometry. (3) : (Prereq: MATH 241) Parameterized curves, regular curves, and surfaces, change of parameters, tangent planes, the differential of a map, the Gauss map, first and second fundamental forms, vector fields, geodesics, and the exponential map.

552–Applied Complex Variables. (3): (Prereq: MATH 241) Complex integration, calculus of residues, conformal mapping. Taylor and Laurent Series expansions, applications.

554–Analysis I. (3): (Prereq: MATH 241) Least upper bound axiom, the real numbers, compactness, sequences, continuity, uniform continuity, differentiation, Riemann integral and fundamental theorem of calculus.

555–Analysis II. (3) : (Prereq: MATH 554 or consent of department) Riemann-Stieltjes integral, infinite series, sequences and series of functions,uniform convergence, Weierstrass approximation theorem, selected topics from Fourier series or Lebesgue integration.

561–Introduction to Mathematical Logic. (3): (Prereq: MATH 241) Syntax and semantics of formal languages; sentential logic; proofs in first order logic; Gödel's completeness theorem; compactness theorem and applications; cardinals and ordinals; the Löwenheim-Skolem-Tarski theorem; Beth's definability theorem; effectively computable functions; Gödel's incompleteness theorem; undecidable theories.

562–Theory of Computation. [= CSCE 551] (3): (Prereq: CSCE 213 and CSCE 330, or MATH 526, or MATH 544, or MATH 574) Basic theoretical principles of computer science as modeled by formal languages and automata; computability and computational complexity.

570–Discrete Optimization. (3) : (Prereq: MATH 526 or 544) Discrete mathematical models. Applications to such problems as resource allocation and transportation. Topics include linear programming, integer programming, network analysis, and dynamic programming.

574–Discrete Mathematics I. (3): (Prereq: MATH 142) Mathematical models; mathematical reasoning; enumeration; induction and recursion; tree structures; networks and graphs; analysis of algorithms.

575–Discrete Mathematics II. (3): (Prereq: MATH 574) A continuation of MATH 574. Inversion formulas; Polya counting; combinatorial designs; minimax theorems; probabilistic methods; Ramsey theory; other topics.

576–Combinatorial Game Theory. (3): (Prereq: MATH 526, 544 or 574) Winning in certain combinatorial games such as Nim, Hackenbush, and Domineering. Equalities and inequalities among games, Sprague-Grundy theory of impartial games, games which are numbers.

580–Elementary Number Theory. (3): (Prereq: MATH 241) Divisibility, primes, congruences, quadratic residues, numerical functions, Diophantine equations.

599–Topics in Mathematics. (1-3): Recent developments in pure and applied mathematics selected to meet current faculty and student interest.

650–AP Calculus for Teachers. (3): (Prereq: current secondary high school teacher certification in mathematics and at least 6 hours of calculus) A thorough study of the topics to be presented in AP calculus, including limits of functions, differentiation, integration, infinite series, and applications. (Not intended for degree programs in mathematics.)

700–Linear Algebra. (3) : Vector spaces, linear transformations, dual spaces, decompositions of spaces, and canonical forms.

701–Algebra I. (3): (Prereq: MATH 700) Algebraic structures, sub-structures, products, homomorphisms, and quotient structures of groups, rings, and modules.

702–Algebra II. (3): (Prereq: MATH 701) Fields and field extensions Galois theory, topics from: transcendental field extensions, algebraically closed fields, finite fields.

703, 704–Analysis I, II. (3 each): Compactness, completeness, continuous functions. Outer measures, measurable sets, extension theorem and Lebesgue-Stieltjes measure. Integration and convergence theorems. Product measures and Fubini's theorem. Differentiation theory. Theorems of Egorov and Lusin. Lp-spaces. Analytic functions: Cauchy-Riemann equations, elementary special functions. Conformal mappings. Cauchy's integral theorem and formula. Classification of singularities, Laurent series, the Argument Principle. Residue theorem, evaluation of integrals and series.

705–Analysis III. (3): (Prereq: MATH 703, 704) Signed and complex measures, Radon-Nikodym theorem, decomposition theorems. Metric spaces and topology, Baire category, Stone-Weierstrass theorem, Arzela-Ascoli theorem. Introduction to Banach and Hilbert spaces, Riesz representation theorems.

706–Numerical Linear Algebra (3): (Prereq: Math 700 or consent of the department) Matrix factorizations; iterative methods including pre-conditioning, iterative methods for eigenvalue problems, singular value decomposition, least squares. Includes theoretical development of concepts and practical algorithm implementation.

710–Probability Theory I. [= **STAT 710**] **(3):** (Prereq: STAT 511, 512, or MATH 703) Probability spaces, random variables and distributions, characteristic functions, laws of large numbers, and the central limit theorem.

711–Probability Theory II. [= **STAT 711**] **(3) :** (Prereq: MATH 710) More about distributions, limit theorems, conditioning, random walks, Brownian motion, and other stochastic processes.

716–Selected Topics in Probability. [= **STAT 716**] **(3):** Fields of study to be individually assigned. Primarily for doctoral candidates.

720–Applied Mathematics I. (3): (Prereq: MATH 555 or equivalent) Methods for solving equations from applied mathematics and the natural sciences, including a study of boundary value problems, integral equations, and eigenvalue problems using transform techniques, Green's functions, and variational principles.

721–Applied Mathematics II. (3): (Prereq: MATH 720) Topics in partial differential equations with emphasis on the equations of the natural sciences; includes classifications of higher order equations, existence and uniqueness of solutions, theory of characteristics, basic properties of elliptic and parabolic equations, Dirichlet and Neumann problems, and the Cauchy problem for hyperbolic equations.

722–Numerical Optimization. (3): (Prereq: graduate standing or consent of the department) Topics in optimization; includes linear programming, integer programming, gradient methods, least squares techniques, and discussion of existing mathematical software.

723–Advanced Differential Equations. (3) : (Prereq: MATH 721 or consent of instructor) Advanced topics in ordinary and partial differential equations.

724–Numerical Differential Equations. (3) : Techniques for numerically solving differential equations; includes finite difference methods, Galerkin methods, finite element method, and collocation.

725–Approximation Theory. (3): (Prereq or coreq: MATH 703) Approximation of functions; existence, uniqueness and characterization of best approximants; Chebyshev's theorem; Chebyshev polynomials; degree of approximation; Jackson and Bernstein theorems; B-splines; approximation by splines; quasi-interpolants; spline interpolation.

726–Numerical Analysis I. (3): (Prereq: MATH 554 (or equivalent) and Math 706) Error analysis; approximation of functions by algebraic polynomials, splines, and trigonometric polynomials; divided differences; numerical differentiation; quadrature including Gaussian and Romberg integration; a thorough study of numerical ODEs.

727–Numerical Analysis II. [= **CSCE 761**] **(3):** (Prereq: MATH 726) Continuation of MATH 726.

728–Selected Topics in Applied Mathematics. (3) : Course content varies and will be announced in the schedule of classes by suffix and title.

730, 731–General Topology I, II. (3 each): Topological spaces, filters, compact spaces, connected spaces, uniform spaces, complete spaces, topological groups, function spaces.

732, 733–Algebraic Topology I, II. (3 each): (Prereq: MATH 730 or 705, and 701) The fundamental group, homological algebra, simplicial complexes, homology and cohomology groups, cup-product, triangulable spaces.

734–Differential Geometry. (3): (Prereq: MATH 550) Differentiable manifolds; classical theory of surfaces and hypersurfaces in Euclidean space; tensors, forms and integration of forms; connections and covariant differentiation; Riemannian manifolds; geodesics and the exponential map; curvature; Jacobi fields and comparison theorems, generalized Gauss-Bonnet theorem.

735–Lie Groups. (3) : (Prereq: MATH 705 or 730) Manifolds; topological groups, coverings and covering groups; Lie groups and their Lie algebras; closed subgroups of Lie groups; automorphism groups and representations; elementary theory of Lie algebras; simply connected Lie groups; semisimple Lie groups and their Lie algebras.

738–Selected Topics in Geometry and Topology. (3) : Course content varies and will be announced in the schedule of classes by suffix and title.

740, 741 Algebra III, IV. (3 each): (Prereq: MATH 702) Theory of rings, modules, fields, bilinear forms, and advanced topics in matrix theory.

742–Lattice Theory. (3): (Prereq: MATH 702) Sublattices, homomorphisms and direct products of lattices; freely generated lattices; modular lattices and projective geometries; the Priestley and Stone dualities for distributive and Boolean lattices; congruence relations on lattices.

744–Matrix Theory. (3): (Prereq: MATH 700) Extremal properties of positive definite and hermitian matrices, doubly stochastic matrices, totally non-negative matrices, eigenvalue monotonicity, Hadamard-Fisher determinantal inequalities.

746–Communtative Algebra. (3): (Prereq: MATH 701) Prime spectrum and Zariski topology; finite, integral, and flat extensions; dimension; depth; homological techniques, normal and regular rings.

747–Algebraic Geometry. (3): (Prereq: MATH 701) Properties of affine and projective varieties defined over algebraically closed fields, rational mappings, birational geometry and divisors especially on curves and surfaces, Bezout's theorem, Riemann-Roch theorem for curves.

748–Selected Topics in Algebra. (3): Course content varies and will be announced in the schedule of classes by suffix and title.

750–Fourier Analysis. (3): (Prereq: MATH 703 and 704) The Fourier transform on the circle and line, convergence of Fejer means; Parseval's relation and the square summable theory, convergence and divergence at a point; conjugate Fourier series, the conjugate function and the Hilbert transform, the Hardy-Littlewood maximal operator and Hardy spaces.

752–Complex Analysis. (3): (Prereq: MATH 703, 704) Normal families, meromorphic functions, Weierstrass product theorem, conformal maps and the Riemann mapping theorem, analytic continuation and Riemann surfaces, harmonic and subharmonic functions.

754–Several Complex Variables. (3) : (Prereq: MATH 703 and 704) Properties of holomorphic functions of several variables, holomorphic mappings, plurisubharmonic functions, domains of convergence of power series, domains of holomorphy and pseudoconvex domains, harmonic analysis in several variables.

755–Applied Functional Analysis. (3): (Prereq: MATH 703) Banach spaces, Hilbert spaces, spectral theory of bounded linear operators, Fredholm alternatives, integral equations, fixed point theorems with applications, least square approximation.

756, 757–Functional Analysis I, II. (3 each): (Prereq: MATH 704) Linear topological spaces; Hahn-Banach theorem; closed graph theorem; uniform boundedness principle; operator theory; spectral theory; topics from linear differential operators or Banach algebras.

758–Selected Topics in Analysis. (3): Course content varies and will be announced in the schedule of classes by suffix and title.

760–Set Theory. (3): An axiomatic development of set theory: sets and classes; recursive definitions and inductive proofs; the axiom of choice and its consequences; ordinals; infinite cardinal arithmetic; combinatorial set theory.

761–The Theory of Computable Functions. (3) : Models of computation; recursive functions, random access machines, Turing machines, and Markov algorithms; Church's Thesis; universal machines and recursively unsolvable problems; recursively enumerable sets; the recursion theorem; the undecidability of elementary arithmetic.

762–Model Theory. (3): First order predicate calculus; elementary theories; models, satisfaction, and truth; the completeness, compactness, and omitting types theorems; countable models of complete theories; elementary extensions; interpolation and definability; preservation theorems; ultraproducts.

768–Selected Topics in Foundations of Mathematics. (3): Course content varies and will be announced in the schedule of classes by suffix and title.

770–Discrete Optimization. (3): The application and analysis of algorithms for linear programming problems, including the simplex algorithm, algorithms and complexity, network flows, and shortest path algorithms. No computer programming experience required.

774–Discrete Mathematics I. (3): An introduction to the theory and applications of discrete mathematics. Topics include enumeration techniques, combinatorial identities, matching theory, basic graph theory, and combinatorial designs.

775–Discrete Mathematics II. (3): (Prereq: MATH 774 or consent of the instructor) A continuation of MATH 774. Additional topics will be selected from: the structure and extremal properties of partially ordered sets, matroids, combinatorial algorithms, matrices of zeros and ones, and coding theory.

776–Graph Theory I. (3) : The study of the structure and extremal properties of graphs, including Eulerian and Hamiltonian paths, connectivity, trees, Ramsey theory, graph coloring, and graph algorithms.

777–Graph Theory II. (3) : (Prereq: MATH 776 or consent of instructor) Continuation of MATH 776. Additional topics will be selected from: reconstruction problems, independence, genus, hypergraphs, perfect graphs, interval representations, and graph-theoretical models.

778–Selected Topics in Discrete Mathematics. (3): Course content varies and will be announced in the schedule of classes by suffix and title.

780–Elementary Number Theory. (3): Diophantine equations, distribution of primes, factoring algorithms, higher power reciprocity, Schnirelmann density, and sieve methods.

782, 783–Analytic Number Theory I, II. (3): (Prereq: MATH 580 and 552) The prime number theorem, Dirichlet's theorem, the Riemann zeta function, Dirichlet's L-functions, exponential sums, Dirichlet series, Hardy-Littlewood method partitions, and Waring's problem.

784–Algebraic Number Theory. (3): (Prereq: MATH 546 and 580) Algebraic integers, unique factorization of ideals, the ideal class group, Dirichlet's unit theorem, application to Diophantine equations.

785–Transcendental Number Theory. (3): (Prereq: MATH 580) Thue-Siegel-Roth theorem, Hilbert's seventh problem, Diophantine approximation.

788–Selected Topics in Number Theory. (3): Course content varies and will be announced in the schedule of classes by suffix and title.

790–Graduate Seminar. (1): (Although this course is required of all candidates for the master's degree it is not included in the total credit hours in the master's program.)

798–Directed Readings and Research. (1-6): (Prereq: full admission to graduate study in mathematics).

799–Thesis Preparation. (1-9): For master's candidates.

890–Graduate Seminar. (1-3): (Prereq: consent of instructor) A review of current literature in specified subject areas involving student presentations. Content varies and will be announced in the schedule of classes by suffix and title. Minimum of 3 credit hours required of all doctoral students. (Pass/Fail Grading)

899–Dissertation Preparation. (1-12): For doctoral candidates.

700-I Level Courses

Note: The courses listed below are for candidates for the degree of Master of Mathematics or Master of Arts in Teaching, or for special graduate students interested in secondary school teaching.

701-I–Foundations of Algebra I. (3) : (Prereq: MATH 241 or equivalent) An introduction to algebraic structures; group theory including subgroups, quotient groups, homomorphisms, isomorphisms, decomposition; introduction to rings and fields.

702-I–Foundations of Algebra II. (3): (Prereq: MATH 701-I or equivalent) Theory of rings including ideals, polynomial rings, and unique factorization domains; structure of finite groups; fields; modules.

703-I–Foundations of Analysis I. (3): (Prereq: MATH 241 or equivalent) The real numbers and least upper bound axiom; sequences and limits of sequences; infinite series; continuity; differentiation; the Riemann integral.

704-I–Foundations of Analysis II. (3): (Prereq: MATH 703-I or equivalent) Sequences and series of functions; power series, uniform convergence; interchange of limits; limits and continuity in several variables.

712-I–Probability and Statistics. (3): This course will include a study of permutations and combinations; probability and its application to statistical inferences; elementary descriptive statistics of a sample of measurements; the binomial, Poisson, and normal distributions; correlation and regression.

736-I–Modern Geometry. (3): (Prereq: MATH 241 or equivalent) Synthetic and analytic projective geometry, homothetic transformations, Euclidean geometry, non-Euclidean geometries, and topology.

752-I–Complex Variables. (3): (Prereq: MATH 241 or equivalent) Properties of analytic functions, complex integration, calculus of residues, Taylor and Laurent series expansions, conformal mappings.

780-I–Theory of Numbers. (3): (Prereq: MATH 241 or equivalent) Elementary properties of integers, Diophantine equations, prime numbers, arithmetic functions, congruences, and the quadratic reciprocity law.

Appendix V: The Graduate Degree Recipients

Doctoral Degrees

1. **George Benjamin Lampton** Advisor: Sonner
   Abstract Abelian categories.
   August 1964

2. **Billy Hoyte Maddox** Advisor: Enochs
   Absolutely pure modules.
   January 1965

3. **William Wilson Leonard** Advisor: Enochs
   Some results on small modules.
   March 1965

4. **James C. Pleasant** Advisor: Enochs
   Certain relations between objects and morphisms in arbitrary categories and module categories.
   March 1965

5. **John Pelham Thomas** Advisor: Enochs
   Maximal topological spaces.
   March 1965

6. **Carol Stone Fritz** Advisor: Sonner
   The dependence of initial structure on universes and forgetful functors.
   April 1965

7. **Arthur Van De Water** Advisor: Enochs
   A property of modules over rings with a left field of quotients.
   April 1967

8. **John Stanley Hinkel** Advisor: Matthies
   Locally convex pseudo-topological vector spaces.
   April 1968

9. **Joong Ho Kim** Advisor: Enochs
   Note on complete local rings.
   August 1968

10. **James Reaves Smith** Advisor: Enochs
    Local domains with topologically T-nilpotent radical.
    August 1968

11. **David Ross Stone** Advisor: Enochs
    Torsion-free and divisible modules over matrix rings.
    August 1968

12. **Paul Edwin Bland** Advisor: Caldwell
    On rational and quasi-rational extensions of modules.
    August 1969

13. **Conduff G. Childress** Advisor: Enochs
    Quotients of hom and torsionness.
    August 1969

14. **John Douglas Faires** Advisor: Birnbaum
    Comparison of the states of a pair of closed linear transformations acting between two Banach spaces.
    June 1970

15. **Simon Chih-Hsiung Hsieh** Advisor: Scheiblich
    Contributions to the theory of semilattices.
    August 1970

16. **Joseph Edward Cicero** Advisor: Melton
    Pseudo Boolean valued rings : algebraic and geometric theory.
    May 1971

17. **George David Zahn** Advisor: Phillips
On the additive structure of non-standard models of arithmetic.
June 1971

18. **Alan Bernard Cantor** Advisor: Phillips
Minimal proper elementary extensions of N *with respect to definable relations.*
May 1972

19. **Joseph Malterer John Bode** Advisor: Sperry
t*-functors and fully invariant subgroups.*
August 1972

20. **Robert Marsden Chapman** Advisor: Sperry
Filtered products of Abelian groups.
December 1972

21. **Yen-Shon Chen** Advisor: Sperry
Torsion theory and relative homological algebra.
January 1973

22. **Don M. Jordan** Advisor: Markham
Completely positive matrices.
August 1973

23. **Leslie Harrison Crabtree** Advisor: Yang
On dual spaces of groups and transformation groups.
May 1974

24. **Nathaniel Knox** Advisor: Scheiblich
On the inverse semigroup coproduct of an arbitrary non-empty collection of groups.
August 1974

25. **Ruth Schulmann Feigenbaum** Advisor: Scheiblich
Kernels of regular semigroup homomorphisms.
June 1975

26. **Ching-hsiang Hung** Advisor: Markham
The Moore-Penrose inverse of a partitioned matrix $M = \begin{pmatrix} A & C \\ B & D \end{pmatrix}$ *with applications.*
June 1975

27. **I-wen Kuo** Advisor: Markham
On singular M*-matrices.*
June 1975

28. **John Isham Moore** Advisor: Trotter
Graphs and partially ordered sets.
June 1975

29. **Dennis P. Geoffroy** Advisor: Sumner
Neighborhood relations in finite graphs.
August 1975

30. **Emma Jane Riddle** Advisor: Markham
The Drazin pseudoinverse : existence, properties, and computation.
June 1976

31. **Cony Mung-Shek Lau** Advisor: Markham
Triangular factorizations of a matrix.
May 1977

32. **Arthur C. H. Lee** Advisor: Padgett
Random contractors and random nonlinear operator equations with applications.
May 1977

33. **Lynn Hauser Pearce** Advisors: Durham and Sumner
Random walks on graphs.
May 1977

34. **Wei Duan** Advisor: Taylor
Convergence of weighted sums of random elements and statistical applications.
August 1977

35. **Peter Daffer** Advisor: Taylor
Laws of large numbers for $D[0,1]$ *and related topics.*
May 1978

36. **Tze Ree Chang** Advisor: Stoll
Invertible and weakly invertible functions in certain spaces of analytic functions.
August 1978

37. **Douglas Frank** Advisor: Durham
Brownian motion on binary trees.
August 1978

38. **Susan Lee** Advisors: Locke and Spurrier
The uses of U*-statistics for testing exponentiality.*
August 1978

39. **Celia Lane Adair** Advisor: Scheiblich
Varieties of $*$*-orthodox semigroups.*
August 1979

40. **Manton McCutchen Matthews** Advisor: Sumner
Properties of clawfree graphs.
August 1980

41. **Laurie Boyle Hopkins** Advisor: Trotter
Some problems involving combinatorial structures determined by intersections of intervals and arcs.
August 1981

42. **Sheng-Ping Lo** Advisor: Trotter
Graph labeling and optimization problems.
August 1981

43. **Nieves Austria McNulty** Advisor: Johnson
Quasi-Newton methods using LU-updates.
August 1982

44. **Ted R. Monroe** Advisor: Trotter
Point unstable and almost point unstable graphs.
August 1982

45. **Patricia M. Blitch** Advisor: Sumner
Domination in graphs.
May 1983

46. **Reginald Koo** Advisor: Bennett
Sharp inequalities for the conjugate function.
August 1985

47. **Valerie A. Miller** Advisor: Neumann
Successive overrelaxation methods for solving large scale rank deficient least squares problems.
August 1985

48. **Ewa Wojcicka** Advisor: Stoll
Functions of bounded characteristic in multiply connected domains.
August 1985

49. **Zheng Yan** Advisor: DeVore
Monotonicity preserving curve fitting algorithms.
August 1985

50. **Bing Zhou** Advisor: Trotter
Topics in graph theory.
August 1986

51. **Mabruk Ali Sola** Advisor: Nyikos
Roy's space Δ *and its compactification.*
May 1987

52. **Chiang Lin** Advisor: Trotter
Dimension, crossing number, and related parameters for finite partially ordered sets.
August 1987

53. **David Barry Rowe** Advisor: Roberts
Compact convex sets in $L_p(w), 0 < p < 1$.
August 1987

54. **Yong S. Shim** Advisor: Sharpley
Maximal function techniques in elliptic linear partial differential equations.
July 1988

55. **Tamas Erdelyi** Advisor: Nevai
Inequalities for generalized polynomials and their applications.
May 1989

56. **Margaret Linley Reese** Advisor: Roberts
An example related to the atomic space problem.
May 1989

57. **Yingkang Hu** Advisor: DeVore
Geometric modeling of densely distributed data.
August 1989

58. **Mingshen Wu** Advisor: Griggs
Algorithms for spanning trees with many leaves and for edge colorings of multigraph.
August 1989

59. **Kwan-Ching Yeh** Advisor: Griggs
Labeling graphs with a condition at distance two.
May 1990

60. **Mark B. Beintema** Advisor: Miller
Gorenstein algebras with unimodal h*-sequences.*
August 1990

61. **Susan M. Palmer** Advisor: Kustin
Algebra structures on resolutions of rings defined by grade four almost complete intersections.
August 1990

62. **Guanshen Ren** Advisor: Nyikos
On non-archimedean normed spaces.
August 1990

63. **Charles Herbert Still** Advisor: Johnson
Parallel methods for unconstrained optimization.
August 1990

64. **Shih-Hua Liu** Advisor: Stoll
Boundary limits of generalized Green potentials on the unit ball in $\mathbf{R}^n$.
May 1991

65. **Hsinjung Chen** Advisor: Roberts
Compact convex sets and the Barycenter in L_0^+.
August 1991

66. **Weihu Hong** Advisor: Sharpley
Interpolation of function spaces.
August 1991

67. **Jamel Abdelhamid Kammoun** Advisor: Nyikos
Products with a κ*-metrizable factor.*
August 1991

68. **Kuo Ming Li** Advisor: Roberts
L_0-type spaces.
August 1991

69. **Der-Fen Daphne Liu** Advisor: Griggs
Graph homomorphisms and channel assignment problem.
August 1991

70. **Hsing-Win Christine Sun** Advisor: Griggs
Binomial determinants with applications.
August 1991

71. **Shiying Zhao** Advisors: Howard and Stoll
On the boundary behaviour of subharmonic functions in nontangential accessible domains.
August 1991

72. **Yousef A. Bdeir** Advisor: Stephenson
P- minimal and P - closed spaces.
August 1992

73. **Colin R. Day** Advisor: Schep
Spectral mapping theorems for fractionally integrated semigroups.
August 1992

74. **Chia-chang Hsiao** Advisor: Jawerth
Rectangular wavelets and compression of operators.
August 1992

75. **George C. Kyriazis** Advisor: DeVore
Wavelet decompositions and spaces of functions.
August 1992

76. **Kenneth Fletcher Yarnall** Advisors: Jawerth and Sharpley
Sampling theorems and wavelet bases.
August 1992

77. **Yuan-Chuan Lin** Advisor: Griggs
Planar graphs with few vertices of small degree.
May 1993

78. **Baiqiao Deng** Advisor: Jawerth
Biorthogonal wavelet packets.
August 1993

79. **Koffi Baana Fadimba** Advisor: Sharpley
Regularization and numerical methods for a class of porous medium equations.
August 1993

80. **Yu-Ping Hsu** Advisor: Dilworth
The uniform Kadec-Klee property in the unitary matrix spaces C_E and the Lorentz spaces $L_{w,1}$.
August 1993

81. **Kimball Jonas** Advisor: Griggs
Graph coloring analogues with a condition at distance two: $L(2,1)$-labellings and list λ-labellings.
August 1993

82. **Mong-Shu Lee** Advisor: Jawerth
Smoothness spaces via wavelets on the closed interval $[0,1]$.
August 1993

83. **Paul D. Sisson** Advisor: Roberts
Compact operators on trivial-dual spaces.
August 1993

84. **Davorin Dujmovic** Advisor: McNulty
Infinite finitely presentable simple groups : membership problem, free subgroups.
August 1994

85. **Marius Mitrea** Advisor: Jawerth
Clifford algebras in harmonic analysis and elliptic boundary value problems on nonsmooth domains.
August 1994

86. **Leszek Piatkiewicz** Advisor: Nyikos
Paracompact subspaces in box product topology and the equivalence in some consequences of the proper forcing axiom.
August 1994

87. **Peter C. Von Rosenberg** Advisor: Nyikos
Countable and finite migrant covers.
August 1994

88. **Qun Wu** Advisor: Jawerth
p-Wavelets and their applications.
August 1994

89. **Jianxin Ouyang** Advisor: Griggs
$(0,1)$-*Matrices without any half-half all* 1*'s submatrix and connectivity of* k*-cromatic graphs.*
December 1994

90. **Brian Douglas Beasley** Advisor: Filaseta
The distribution of powerfree values of irreducible polynomials.
May 1995

91. **Florin Sabac** Advisor: DeVore
Nonlinear hyperbolic conservation laws.
May 1995

92. **Zesheng Yang** Advisor: DeVore
Wavelets and image compression.
May 1995

93. **Kuzman Adzievski** Advisor: Stoll
Boundary behavior of pluri-Green potentials in the unit ball of $\mathbb{C}^n$.
August 1995

94. **James T. Allis** Advisor: Roberts
The quotient of the space of measurable funtions by the closed linear span of the Rademacher functions.
August 1995

95. **Leszek Rzepecki** Advisor: Stoll
Boundary behavior of non-isotropic potentials in the unit ball of $\mathbb{C}^n$.
August 1995

96. **Kara Lee Walcher** Advisor: Sumner
Matching extensions in the powers of graphs.
August 1995

97. **Anping Chen** Advisor: Jawerth
Compactly supported bidimensional biorthogonal wavelet bases with globally invariant by a Θ *rotation.*
August 1996

98. **Zsolt Lengvarszky** Advisor: McNulty
Independent subsets in lattices.
August 1996

99. **Wei Shao** Advisor: DeVore
Image processing and neural networks.
August 1996

100. **Junior Solan** Advisor: Filaseta
Norms of factors of polynomials, an extension of a theorem of Ljunggren, and the distribution of k*-free numbers.*
August 1996

101. **Pinghua Wang** Advisor: DeVore
Wavelet characterizations of Besov spaces in $L^p(\Omega)$ $0 < p \leq 1$.
August 1996

102. **Weimin Zheng** Advisor: Jawerth
Wavelets and applications to signal processing and PDEs.
August 1996

103. **Chuanzhong Zhu** Advisor: Griggs
Results on intersecting families of subsets of a finite set.
June 1996

104. **Vladimir V. Dubinin** Advisor: Temlyakov
Greedy algorithms and applications.
May 1997

105. **Peter L. Sandberg** Advisor: Griggs
Finding independent sets in connected graphs without large complete subgraphs.
May 1997

106. **Mohamed A. Al-Lawatia** Advisor: Sharpley
Algorithm development and numerical analysis of transport equations.
August 1997

107. **Emil-Adrian Cornea** Advisor: Jawerth
Multiresolution analysis of nonlinear phenomena arising in surface modeling.
August 1997

108. **Marton Nagy** Advisor: McNulty
Expandably finitely based algebras.
August 1997

109. **Chunliang Pan** Advisor: Nyikos
Insertion properties of monotonically defined topological spaces.
August 1997

110. **Tibor Szarvas** Advisor: Roberts
Uniform $L_p(w)$-spaces.
August 1997

111. **Chih-Chang Ho** Advisor: Griggs
The cycling of partitions and compositions under repeated shifts.
May 1998

112. **Yu Chen** Advisor: Kossowski
Global differential geometry of 1-resolvable C^∞ curves in the plane.
August 1998

113. **Zhenguang Gao** Advisor: Sharpley
The wavelet transform and data compression.
August 1998

114. **Laszlo Zsilinszky** Advisor: Nyikos
Topological games and hyperspace topologies.
August 1998

115. **Eva Czabarka** Advisor: Griggs
Shifting in finite vector spaces.
December 1998

116. **Zoltan Szekely** Advisor: McNulty
Complexity of the finite algebra membership problem for varieties.
December 1998

117. **Shushuang Man** Advisor: Wang
A family of Eulerian-Lagrangian localized adjoint methods for two-dimensional transport equations and their error analyses.
May 1999

118. **Guergana P. Petrova** Advisor: Devore
Transport equations and velocity averages.
August 1999

119. **Bojan Popov** Advisor: DeVore
Linear transport equations.
August 1999

120. **Alexander V. Andrianov** Advisor: Temlyakov
Nonlinear Haar approximation of some multivariate classes of functions.
May 2000

121. **Kimberly J. Presser** Advisor: Miller
An analysis of the maximal growth of Hilbert functions.
May 2000

122. **Qingmi He** Advisor: Brenner
A theoretical study of three dimensional nonoverlapping domain decomposition methods.
August 2000

123. **David Sanjit Mitra** Advisor: Girardi
Sequences that are unconditionally basic in both l_1 *and* l_2.
August 2000

124. **Richard Lanier Williams** Advisor: Filaseta
The irreducibility of a certain class of Laguerre polynomials.
August 2000

125. **Brendan F. Lane** Advisor: Sharpley
Multiresolution analysis for the registration of images.
May 2001

126. **Martha Ann Allen** Advisor: Filaseta
Generalizations of the irreducibility theorems of I. Schur.
August 2001

127. **Tamara Burton** Advisor: Sumner
Domination dot critical graphs.
August 2001

128. **Akira Iwasa** Advisor: Nyikos
Metrizability of trees.
August 2001

129. **Angel V. Kumchev** Advisor: Filaseta
Diophantine problems involving prime numbers.
August 2001

130. **Borislav Karaivanov** Advisor: Petrushev
Nonlinear piecewise polynomial approximation: theory and algorithms.
December 2001

131. **Jiangguo Liu** Advisor: Wang
Efficient numerical techniques for advection dominated transport equations.
December 2001

Master of Arts Degrees

1. **Wyman Loren Williams**
   Power series.
   1924

2. **Julia Agatha Bailey**
   Correlation.
   1926

3. **Roy Calhoun Cobb**
   The transcendence of the number e.
   1927

4. **Sarah Baylor Meredith**
   The development of the idea of the infiniteness of the universe.
   1927

5. **Paul Edwin Gravely**
   The Taylor series for real variables.
   1928

6. **Lonnie Langston**
   The catenary.
   1928

7. **Alice Childs Urquhart**
   The normal probability curve.
   1928

8. **Marie Cleopatra Bryant**
   The transcendence of the number Pi.
   1930

9. **Belle Nickels**
   Indeterminate forms.
   1930

10. **Mary Gervais Watson**
    Pascal's theorem.
    1931

11. **William Harris Willis**
    The nine point circle and some theorems connected with it.
    1931

12. **Mary Gervais Watson**
    Lines and planes of best fit and correlation.
    1932

13. **James Henry Carlisle**
    Fitting a line to points in three dimensional space, each of the coordinates being subject to error simultaneously, and a coefficient of linear correlation for the points.
    1942

14. **Hasell Thomas LaBorde** — Advisor: Williams
    The curved surface area of an oblique circular cone.
    1948

15. **Lillian Glenn Perkins**
    Projective generalizations of theorems in metric geometry.
    1949

16. **Betty Rose Weber** — Advisor: Novak
    Conditions for the reduction and formulae for the solution of the linear partial differential equation of the second order.
    1949

17. **Stephen Taylor Martin**
The correspondence between the circles of two-dimensional metric space and the points of three-dimensional projective space.
1956

18. **Ralph Surasky** Advisor: Cohen
Asymptotic properties of certain arithmetical functions.
1956

19. **Robert Douglas Allsbrook** Advisor: Fort
The tractrix and related curves.
1958

20. **Chung-lie Wang**
The structure of a semigroup.
1959

21. **Russell Emery Thompson** Advisor: Fort
Conformal mapping methods.
June 1959

22. **Hsiu Hsu Huang**
Global existence theorems of ordinary differential equations.
1960

23. **Lucy Carol Cobb** Advisor: Strebe
Operators in topology.
1961

24. **Wai-Kit Leung**
Properties of groups inherited by subgroups and factor groups.
1961

25. **Robert Reece Highfill**
The Trojan three-body problem with elliptical orbits.
1963

26. **Donald Graham Aplin**
Partial categories.
1965

27. **Earl E. McGehee**
Some generalized notions of compactness.
1965

28. **Elaine H. Shawaker**
Selected canonical homomorphisms.
1965

29. **Sherman Louie**
Cyclic modules.
1966

30. **Elsie Sandra Cockrell McLaurin**
Enlargement of local categories.
1967

31. **Don M. Jordan** Advisor: Boal
Numerical solutions of ordinary differential equations.
1968

32. **Wade Hampton Sherard III** Advisor: Sperry
On the complementation of topologies.
1968

33. **Gretchen Miller Mooningham** Advisor: Sperry
Abelian groups with minimal systems of generators.
1969

34. **William Edward Bratten** Advisor: Birnbaum
Fixed point theorems and functional equations.
1969

35. **David Barry Rowe** Advisor: Scheiblich
The lattice of congruences on a completely O-simple semigroup.
August 1969

36. **Celia Lane Adair** Advisor: Deeds
Equivalent formulations and applications of the Cauchy integral theorem.
June 1971

37. **Dennis P. Geoffroy** Advisor: Winton
Torsion theory in Abelian categories with applications to ring theory.
June 1972

38. **John Isham Moore** Advisor: Winton
Rings of quotients.
August 1972

39. **Maria Maffitt Ward** Advisor: Winton
Ring injective hulls and ring injective cogenerators.
1972

40. **Hai-ching Chang** Advisor: Nicol
Schur's problem and its generalization.
August 1973

41. **Emma Jane Riddle** Advisor: Winton
Adjoint groups in radical and Artinian rings.
August 1973

42. **William Frederick Roller** Advisor: Padgett
Weak convergence of probability measures on certain spaces of functions.
1973

43. **Joseph Cleveland Ard** Advisor: Harley
Homology theory and path maps.
1973

44. **Joseph Michael Lynch** Advisor: Taylor
Weak convergence and central limit theorems in certain Banach spaces.
August 1974

45. **Thomas Pierce Odom** Advisor: Taylor
Limit laws of random elements.
August 1974

46. **Duan Wei** Advisor: Padgett
$\mathbf{R}^m$*-valued and Banach space-valued random solutions of a nonlinear stochastic integral equation.*
1975

47. **Jenny G. Wei** Advisor: Spurrier
Some tests for normality against nonsymmetric alternatives.
May 1976

48. **James C. Crabtree** Advisor: Taylor
Martingales in Banach spaces.
August 1977

49. **Kai Wang** Advisor: Padgett
Bayes estimation of the Inverse Gaussian Lifetime Model.
August 1980

50. **Timothy Lawrence Szeliga** Advisor: Trotter
Constructive proofs of some combinatorial theorems.
August 1981

51. **Paul Brannen Peeples** Advisor: Ross
Augmenting paths and the blossom algorithm.
December 1982

52. **Juan B. Sanchiz** Advisor: Sharpley
Harmonic analysis on the unit disc.
December 1982

53. **Yong S. Shim** Advisor: Schep
Summability of eigenvalues of Hille-Tamarkin operators.
August 1984

54. **Margaret Linley Reese** Advisor: Roberts
Measure island.
August 1986

55. **Sneh Gulati** Advisor: Griggs
A study of Sperner theory and its application to $L(m, n)$-the Young's Lattics.
May 1987

56. **Stephen Gerard Penrice** Advisor: Kierstead
Lexical matchings in the middle levels of the Boolean lattice.
May 1988

57. **Chuck Baldwin** Advisor: johnson
Successive approximation techniques for hypercubes.
December 1988

58. **Colin Richard Day** Advisor: Kustin
Ring around the poset : an introduction to algebras with straightening law.
December 1989

59. **Hsing-Win Christine Sun** Advisor: Griggs
A study of interval numbers of graphs.
December 1989

60. **Timothy Albert Swartz** Advisor: Nyikos
Internal forcing axioms and the continuum.
December 1989

61. **James T. Allis** Advisor: Roberts
Generalized barycenters.
August 1990

62. **Yi-Jen Liao** Advisor: Sharpley
An analysis of the wave equations.
August 1990

63. **George L. Vairaktarakis** Advisor: J. Walker
The timetable problem.
August 1990

64. **David L. Harvey** Advisor: McNulty
Computing all reduced Grobner bases for polynoimial ideals in two variables.
May 1991

65. **Ruojun Gan** Advisor: Sharpley
Interface condition for seismic wave propagation.
August 1992

66. **Fabian Chudak** Advisor: Griggs
On quotient possets and the LYM-inequality and convex hulls of families of subsets.
August 1994

67. **Henry Philip Crotwell** Advisor: Sharpley
Two dimensional seismic simulations and seismogram interpretation for the inverse problem.
1994

68. **Xhano Soares** Advisor: Kustin
An excursion into Noether's problem in Galois theory.
August 1995

69. **Christopher M. Roscoe** Advisor: Johnson
A modified trust region strategy for parameter identification in ordinary differential equations.
May 1996

70. **David Sanjit Mitra** Advisor: Girardi
Some trees constructed by Roberts, Bourgain, and Rosenthal, from independent, equidistributed random variables that are close to zero in measure.
May 1998

71. **Chong Li** Advisor: Szekely
Minimum spanning trees and more : algorithms and analysis.
August 1998

72. **Martha Ann Allen** Advisor: Filaseta
The irreducibility theorems of I. Schur.
May 1999

73. **Brian Carnes** Advisor: Dix
Nonlinear Fourier transforms for solving the modified Korteweg-de Vries equation.
August 1999

74. **Jason Matthew Burns** Advisors: Sumner and Szekely
Recent results on extremal problems in the subdivision of graphs.
August 2000

75. **Jun Han** Advisor: Brenner
Preconditioning the P2 finite element by the P1 finite element.
December 2000

76. **Jue Wang** Advisor: Wang
Mathematical and numerical modeling for American options.
August 2002

Master of Science Degrees

1. **Robert Ledbetter Jones**
The evaluation of certain definite integrals by application of the gamma function.
1928

2. **Herbert Richardson Smith**
The cycloid.
1930

3. **Levi Robert Shirley**
The definition of irrational numbers.
1931

4. **Gladys Hamilton**
Limits.
1932

5. **Perry William Jayroe**
The graphical solution of equations through the fourth degree.
1932

6. **Bryan Simmons Pinson**
Horner's method of the equation.
1933

7. **Sanders Richardson Guignard**
Plane fitting in three dimensional space.
1934

8. **Mabel Olivia Johnson**
Some relations coming from Miguel's theorem for circles.
1934

9. **Lorence David Laird**
A study of index numbers.
1934

10. **William Isaac Layton**
Concerning circles related to a triangle.
1935

11. **Rowland Herbert Bishop**
A study in involutions.
1937

12. **Ralph Dennis Derrick**
A problem in conic sections.
1938

13. **Florence Mauldin Anderson**
A solution of the problem of Apollonius in polar coordinates.
1939

14. **George Edmund David Sullivan**
A short history of the number system.
1943

15. **John Lawrence Frierson**
The four nine-point circles associated with a complete quadrangle.
1945

16. **Charles William Huff**
The classification of pairs of quadric surfaces by the method of elementary divisors.
1948

17. **Joseph Francis Cheatham** Advisor: Hedberg
Riemann surfaces and the Newton polygon.
1950

18. **William Munroe Faucett**
Peculiarities of the solutions of a generalized second order linear differential equation.
1950

19. **Carey Chaplin Tison**
The arc length of the involute of a conical spiral.
1950

20. **Chaford Acquilla Brown**
Points of division of the arc of one quadrant of the lemniscate.
1951

21. **George William Haigler** Advisor: Williams
The divisors of zero of the ring of second-order matrices of integers reduced modulo six.
1952

22. **Samuel Moore Hendley**
The theory and construction of addition chains.
1954

23. **Janet Housel Scott**
The Jordan phi-function.
1956

24. **James P. Anderson**
The theory of approximations by polynomials.
1957

25. **Chung Won Chang**
Line coordinates.
1957

26. **Nicholas C. Mitrowsis**
Convergence of Fourier series.
1957

27. **Katye Oliver Sowell** Advisor: Novak
A study of the complex line by the use of geometry of four dimensions.
1958

28. **James Britton Crowell**
Properties of square matrices with real quaternion elements.
1959

29. **Francis Chi-Yu Tang** Advisor: Fort
Factorial Series.
1959

30. **Robert M. Siegmann**
Continuous functions.
1960

31. **Alfred Sho Yu Tang** Advisor: Sonner
The importance and application of some fixed point theorems.
1960

32. **Hugh Blanton Easler** Advisor: Sonner
A survey of literature on derivations and differential forms.
1961

33. **James Francis Sullivan**
Certain aspects of injective modules.
1962

34. **Elleanor Crown Bagramian**
Some results on Q-groups and S-groups.
1963

35. **David Jerman Fortney**
Analytic functions on arbitrary Banach spaces.
1963

36. **Shih-lu Chang**
Derivation of formulas for multivariate interpolation.
1963

37. **William David Ergle**
An introduction to continued fractions.
1963

38. **Julia Phoebe Kennedy**
The group of extensions.
1963

39. **Chuan-fang Kung**
On sets of uniqueness of analytic functions.
1963

40. **William Wilson Leonard**
Injective modules over Noetherian rings.
1963

41. **Conduff G. Childress**
Some properties of essential modules.
1964

42. **John Louis Gieser**
Properties of the multiplicative semigroup of integers modulo m.
1964

43. **David Stuckey Watson** Advisor: Strebe
Sequential convergence with generalizations in topological spaces.
1964

44. **Yun-Cheng Zee**
Projective modules.
1964

45. **Melvin Gordon Seyle Jr.** Advisor: Nicol
The density of sequences of integers.
1964

46. **Edwina Rudisill Beam**
The zeros of orthogonal polynomials.
1965

47. **John Douglas Faires**
Some solutions of the heat problem involving a moving heat source.
1965

48. **Han-Yueh Huang**
p*-adic integers.*
1965

49. **Arthur Van De Water**
On the unboundedness of a restricted partition function.
1965

50. **Ann Fowler Bowe**
Some properties of valuation rings.
1966

51. **Stephen W. Custer**
Certain theorems on the approximation of complex numbers by Gaussian integers.
1966

52. **Joong Ho Kim** Advisor: Enochs
Continuous automorphisms of $K[[X]]$.
1966

53. **Robert H. Martin** Advisor: Boal
Error and relative stability in predictor-corrector methods.
1966

54. **Gerald L. Noelle**
An elementary development of the analytic configuration.
1966

55. **Thomas Bragg Vassar**
Diophantine equations.
1966

56. **Raymond Brandon Young**
An axiomatic development of certain functors.
1966

57. **Charles Seegers Davis**
Conformal mapping.
1967

58. **Barbara Sue Trader**
Tonneau covers.
1968

59. **John William Mooningham**
General topological concepts in limit space theory.
1968

60. **Frances E. Sullivan**
A comparative study of the Frattini subgroup of a group and the Jacobson radical of a ring.
1968

61. **Thomas R. Thomson**
The numerical calculation of the stress distribution at a circular hole in an infinite plate.
1968

62. **Iris Mack Dayoub** Advisor: Sperry
Some generalizations of compactness.
1969

63. **Cho-fong To** Advisor: Matthies
Retracts and non local existence of solutions of differential equations.
1969

64. **Brian Gregory Gordon** Advisor: Phillips
A direct proof of the compactness theorem for higher order languages.
1969

65. **Eileen Bernadette Kilpatrick** Advisor: Boal
Higher order Runge-Kutta formulas.
1969

66. **Kar-Wang Lau**
On the boundedness of solutions of nonlinear differential equations.
1969

67. **John Hsuaowei Yang** Advisor: Markham
Classes of quadratic forms.
1969

68. **Dale Hsieh** Advisor: Melton
Boolean metric spaces and Boolean algebras.
1970

69. **David John Frontz** Advisor: Harley
The Van Kampen theorem and applications.
1971

70. **John Jex Batty** Advisor: Sternbach
The Daniell integral.
1971

71. **Virginia Faulkner Bolton** Advisor: Fuller
Multi-valued functions and topologies on collections of subsets.
1971

72. **Carol Ann Tilton** Advisor: Fuller
Continuity of and relations among non-continuous functions.
1971

73. **Gerald K. Duncan** Advisor: Harley
Some major theorems in metrization theory.
1972

74. **Cynthia DeMatos Geoffroy** Advisor: Scheiblich
Semimodular semilattices.
1972

75. **DiAnn Richardson Moore** Advisor: Taylor
An introduction to Martingales and their applications.
December 1972

76. **Kayran Cox Moore** Advisor: Scheiblich
Semigroup epimorphisms.
1972

77. **Erroll Eugene Collins** Advisor: Taylor
Modes of convergence of Random elements in metric spaces.
May 1972

78. **Richard Woolridge Gill** Advisor: Scheiblich
(h, k) *regular semigroups.*
1972

79. **Thomas Dean Koob** Advisor: Phillips
Non-standard models of arithmetic.
1972

80. **Bruce Carroll Robertson** Advisor: Phillips
Models of arithmetic.
1972

81. **Joyce Williford** Advisor: Sternbach
The derivative of measures.
1972

82. **Gilbert Wallace Black** Advisor: Sumner
Theorems of the Nordhaus-Gaddum class.
1973

83. **Kin-Sheng Joseph Chang** Advisor: Queen
Introduction to generalized functions and numerical aspect of distributions.
1973

84. **William Farrell Fenzel** Advisor: M. Johnson
Regular near-rings.
1973

85. **Bruce E. Hoyt** Advisor: Sternbach
The spectral theorm (sic) for Hermitian operators on Hilbert spaces.
1973

86. **Chi-Sing Lee** Advisor: Sperry
Preradicals on Abelian groups.
1973

87. **Charlene Matthews Linder** Advisor: Winton
Structure and basic properties of group rings.
1973

88. **Seth Larry Price** Advisor: Queen
A stability study of fourth-order corrector equations.
1973

89. **Luther Henry Tison** Advisor: Johnson
Factorizations of differential operators.
1973

90. **Sheng Ping Lo** Advisor: Queen
Abstract norms and optimally scaled matrices.
1973

91. **Lynn Hauser Pearce** Advisor: Winton
Generalizations of Levitski's theorems.
1973

92. **Szu-ting Christina Po** Advisor: Durham
Some fundamental theorems of demography.
1973

93. **Joan Marie Combes** Advisor: Taylor
Standard and nonparametric analysis of academic performance data pertaining to contemporary university.
May 1973

94. **Arthur C. H. Lee** Advisor: Padgett
Estimating linear statistical models.
May 1973

95. **Sung-pei Yu** Advisor: Taylor
Laws of large numbers in normed linear spaces.
May 1973

96. **Gary Doyle Faulkner** Advisor: Harley
Distance spaces and metrization theory.
June 1973

97. **Szu-ting Christina Po** Advisor: Durham
Some fundamental theorems of demography.
August 1973

98. **Raymond Ashby Ayers** Advisor: Johnson
Stability of periodic predator-prey models.
1974

99. **Betsy Ann Edwards** Advisor: Chewning
Boundary control of the heat equation.
1974

100. **Roan A. Garcia-Quintana** Advisor: Taylor
Convergence in random normed spaces of mappings.
May 1974

101. **Lin-Lin Lee** Advisor: Taylor
Stochastic processes and random elements.
May 1974

102. **Shu-Chen Susan Lee** Advisor: Padgett
Some theorems on stochastic calculus.
May 1974

103. **Kuen-jing J. Lien** Advisor: Padgett
Some random integral equations of Volterra type.
May 1974

104. **Paul S. Jaworski** Advisor: Johnson
Generalized Lyapunov functions.
1974

105. **James Ralph Moyer** Advisor: Norris
Machines and order.
1974

106. **Hagop V. Panossian** Advisor: Chewning
Nonlinear parabolic equations with variable boundary data.
1974

107. **Miles S. Pilbeck Jr.** Advisor: Chewning
Coupled nonlinear systems of inhibitor-excitor units.
1974

108. **Rose Condon Hamm** Advisor: Padgett
Existence of solutions of a class of random Hammerstein integral equations.
December 1974

109. **Shewhon Lee** Advisor: Durham
A branching process on a finite Abelian group.
December 1974

110. **Elizabeth Mary Taylor** Advisor: Padgett
Existence and almost sure stability of solutions of random Volterra equations.
December 1974

111. **Jerry Ray Brock** Advisor: Johnson
Finite difference equations related to partial differential equations.
1975

112. **Ichia Atina Chou** Advisor: Underwood
The qualitative theory and computation of solutions of games.
1975

113. **Edwin Milton Dickey** Advisor: Scheiblich
Right group and minimum right group congruences on a semigroup.
1975

114. **Deborah Marlene Estes** Advisor: Sumner
Two parameters and their relationships to Hamiltonian graphs.
1975

115. **James M. Greene** Advisor: Hudson
Some generalizations concerning a classical theorem on quadratic residues.
1975

116. **Chuen S. Huang** Advisor: Matthies
Fundamental properties of analytic functions defined on Banach spaces.
1975

117. **Carolyn Tucker Polston** Advisor: Johnson
A convergent scheme for C^1 boundary control of parabolic equations.
1975

118. **Paul Clifton Spikes Jr.** Advisor: Johnson
Control of sedimentary processes.
1975

119. **Kristine Cathey Yeager** Advisor: Norris
Investigation of a claim in recursion theory with applications to automata.
1975

120. **Dorsey Ann Glenn** Advisor: Durham
Some genetics models with random environments.
May 1975

121. **Douglas Evans McTeer** Advisor: Durham
An optimal investment strategy.
May 1975

122. **John Raymond Schleppegrell** Advisor: Durham
Optimal predation in random and stable environments.
May 1975

123. **Peter Wludyka** Advisor: Taylor
Consistent sequential decision procedures.
May 1975

124. **Rosemary Gramling Dalton** Advisor: Durham
A study in two-type branching allocation processes.
August 1975

125. **Kay Adams Oldhouser** Advisor: Scheiblich
Principal factors in semigroups.
August 1975

126. **John Edward Parsons** Advisor: Roberts
Choquet's theorem and applications.
August 1975

127. **Ione Hendrix Cockrell** Advisor: Durham
Statistical analysis of teacher evaluation data for Fall 1974.
December 1975

128. **Sharon Lee Manzer** Advisor: Hudson
An extension of Meissel's theorem.
1976

129. **Charles Roberts Goddard** Advisor: Norris
On a construction of n-ary relations.
1977

130. **Manton McCutchen Matthews** Advisor: Sumner
Generalized Ramsey numbers.
1977

131. **Ai Ling Irene Chen** Advisor: Padgett
Bayes and minimum variance unbiases estimates of reliability.
August 1977

132. **Martha P. Johnson** Advisor: Padgett
Bayesian lower bounds for reliabilityin teh two-parameter lognormal failure model.
August 1977

133. **Anita F. Lichtman** Advisor: Taylor
Statistical programs written in BASIC-Plus: An interactive approach.
August 1977

134. **David J. Oberly** Advisor: Sumner
Local and Hamiltonian properties of graphs and line graphs.
August 1977

135. **Earl Barrett Kendrick** Advisor: Wei
The design of clinical trials.
December 1977

136. **Nancy Cummings Hoffmann** Advisor: Taylor
Function-valued random variables and stochastic processes.
December 1977

137. **Kathryn Schueing Lott** Advisor: Robinson
A statistical analysis of South Carolina stream chemistry data.
December 1977

138. **Andre Michelle Putz Lubecke** Advisor: Spurrier
Maximumlikelihood estimation of quantal bioassay.
December 1977

139. **Diane T. McNichols** Advisor: Padgett
An analysis of Bayes estimators of reliability for mixed life distributions.
December 1977

140. **Patricia Gorman Monroe** Advisor: Robinson
The effects of assymetry on confidence intervals for location parameters.
December 1977

141. **Adrian H. Thurstin** Advisor: Robinson
A study of FUNOP: detection of outliers and associated test of normality.
December 1977

142. **Su-Lan Cheng** Advisor: White
Block tridiagonal matrices and two-point boundary value problems.
May 1978

143. **William Bond Foster** Advisor: Johnson
Numerical methods for a system of differential and algebraic equations.
May 1978

144. **Ruth A. Meeker** Advisor: Underwood
Optimization by quasi-Newton and conjugate-gradient methods.
1978

145. **Jia-cherng Hwang** Advisor: Chewning
Stability of stochastic nonlinear integral equations.
1979

146. **Wei-Ping Hu Chang** Advisor: Wei
Comparisons between the biased coin design and the urn design in sequential clinical trials.
May 1979

147. **Jia-Cherng Hwang** Advisor: Padgett
Stability of stochastic nonlinear integral equations.
May 1979

148. **Hsien-Ming Hung** Advisor: Wei
The analysis of incomplete paird data.
May 1979

149. **Kung-Yee Liang** Advisor: Padgett
Nonparametric empirical Bayes estimation of reliability.
May 1979

150. **James Jeffery Ashton** Advisor: Spurrier
LINMOD, a statistical computing package.
December 1979

151. **Connie F. Sawyer** Advisor: Taylor
The Markov source as a model for natural languages.
December 1979

152. **Ganga Sivakumar** Advisor: Baker
Statistical programs written in BASIC-Plus: An interactive approach-Phase II.
December 1979

153. **Yea-Sen Lin** Advisor: Padgett
Confidence bounds on reliability for the Inverse Gaussian Model.
May 1980

154. **Carol Ann Calhoun** Advisor: Taylor
Laws of large numbers for $D[0,1]$ *and estimation of density functions.*
August 1980

155. **Patrick E. Flanagan** Advisor: Taylor
Computer programs for kernel estimators of a probability density function.
August 1980

156. **Carlos Ocampo Hinayon** Advisor: Padgett
A study on the estimation of parameters and the reliability function for the Birnbaum-Saunders Fatigue-Life Distribution.
August 1980

157. **Molly M. Jones** Advisor: Spurrier
LINCOM-A statistical computing package for multiple comparisons of means.
August 1980

158. **Daniel Lawrence Toth** Advisors: McNulty and Roberts
Amenability and decompositions of the sphere.
August 1980

159. **Anna Wojcicka Gleissner** Advisor: Houstis
Parallel algorithms and computer architecture for linear equations.
May 1981

160. **John E. Gleissner** Advisor: Spurrier
STATS, a statistical computing system.
May 1981

161. **Todd Jeffrey Schneider** Advisor: McNulty
Vaught's conjecture for trees.
December 1981

162. **Mabruk Ali Sola** Advisor: Nyikos
The Stone-Čech compactification of the integers.
August 1982

163. **Terri Anne Haughton** Advisor: Ross
Network flows and blocking systems.
December 1982

164. **Karen Barbee Smith** Advisor: Markham
The search for eigenvalues based on Rutishauser's LR method.
December 1982

165. **Ali Ahmed Mehemmed** Advisor: Roberts
Kwapiens's theorem.
May 1983

166. **Ripudaman N. Gill** Advisor: Markham
An application of a result of schur in developing the Jordan canonical form of a matrix.
August 1983

167. **Martin Lee Jones** Advisor: Kierstead
A mathematical incompleteness in Peano arithmetic.
August 1983

168. **Vicki Huggins** Advisor: Hathaway
Computing maximum likelihood for normal mixture distributions.
December 1983

169. **John Gregory Bell** Advisor: Markham
The inverse eigenvalue problem for symmetric and nonnegative matrices.
May 1984

170. **David Gerard Jaspers** Advisor: Trotter
An application of Ramsey's theorem to partial orders.
May 1984

171. **Donald Phillip Romano** Advisor: Stephenson
p-closed and p-minimal topolgies.
May 1984

172. **Ronetta Lee Todd** Advisor: Griggs
Recent results on the average running speed of the simplex method in linear programming.
May 1984

173. **Shahryar Heydari** Advisor: Markham
Eigenvalue monotonicity.
August 1984

174. **Janna Bunje** Advisor: Roberts
Kalton's representation of the continous linear operators on the spaces $L_p,\ O < p < l$.
December 1984

175. **Chia-Lin Chin** Advisor: Hathaway
A penalized approach for estimating the parameters of a normal mixture.
December 1984

176. **Michael John Cicero** Advisor: Stephenson
Countable compactness and related topological properties.
May 1985

177. **Stephen Mark Eure** Advisor: Nyikos
The role of trees in topology.
May 1985

178. **Padamjit Singh** Advisor: Matthies
Behavior of conformal maps on the boundaries.
August 1985

179. **Shu-Mei Cheng** Advisor: Johnson
Finite termination of a generalized Broyden method for a system of linear equations.
December 1985

180. **Jung Sun** Advisor: Hathaway
Numerical analysis routines for small computers.
December 1985

181. **Celia Alford Wilson** Advisor: Hathaway
The grouped-variable coordinate descent algorithm.
December 1985

182. **Patrick Boone Conway** Advisor: Johnson
Solving the equality constrained least squares problem by the method of weights.
May 1986

183. **Chih-chen Hu** Advisor: Roberts
Maharam submeasure problem.
May 1986

184. **Margaret Katherine Winkler** Advisor: Sharpley
Comparative analysis of mathematical models of the immune response.
May 1986

185. **Margie Marie Covington** Advisor: Richman
Some impartial games : normal and Misere play.
December 1986

186. **Kenneth Michael Araujo** Advisor: Hathaway
Condition number estimates for solving linear systems.
December 1986

187. **Terri Batts Miley** Advisor: Griggs
An application of bipartite matching to chain partitions.
December 1986

188. **Shyh-Horng Yang** Advisor: Johnson
Residual inverse iteration using variable shifts for the nonlinear eigenvalue problem.
May 1987

189. **Janis Anderson Alexander** Advisor: Filaseta
Irreducibility criteria for polynomials with non-negative coefficients.
May 1987

190. **Nazih Mrad** Advisor: Johnson
Sparse quasi Newton LDU update methods.
August 1987

191. **Eileen Bernadette Carroll** Advisor: MacCluer
Julia-Caratheodory theory and the Denjoy-Wolff theorem.
December 1987

192. **William Michael Kemick** Advisor: Kierstead
On the priority method of Friedberg and Muchnik.
December 1987

193. **Mohammad Moazzem Hossain** Advisor: J. Walker
Why is the simplex method so fast.
May 1988

194. **Joan Burdick Howell** Advisor: Stoll
Harmonic and subharmonic functions on the unit ball in $\mathbf{R}^n$.
May 1988

195. **Damien Michelin** Advisor: Johnson
Microcomputer procedure for management and plotting of structural geologic data on stereographic projections.
May 1988

196. **Craig Edward Winkler** Advisor: Stoll
The Radon transform and computerized tomography.
May 1988

197. **Inhwei Shei Yang** Advisor: Filaseta
Some ballot problems for two candidates.
May 1988

198. **Guang Ma** Advisor: Johnson
A cyclic reduction algorithm for solving the Neumann problem.
August 1988

199. **Melonie Ann Rodgers** Advisor: Filaseta
Problems and results on irreducible poloynomials.
August 1988

200. **Grace E. Feng** Advisor: J. Walker
Shortest-path algorithms and their applications.
December 1988

201. **Grace M. De Ramos** Advisor: Filaseta
Elementary approaches to a gap problem involing k*-free numbers.*
May 1989

202. **W. David Byrd** Advisor: Harley
Distance theory.
August 1989

203. **Jamel Abdelhamid Kammoun** Advisor: Nyikos
Normality in product spaces.
August 1989

204. **Jacklyn R. Pitts** Advisor: Filaseta
On an irreducibility theorem of I. Schur.
August 1989

205. **Zoltan Reti** Advisor: DeVore
Moduli of smoothness and Marchaud's Inequality.
August 1989

206. **Roger E. Rosenthal** Advisor: Filaseta
Dirichlet's theorem for polynomials.
August 1989

207. **Angela M. Andrews** Advisor: Filaseta
On the density of irreducible polynomials with coefficients 0 and 1.
December 1989

208. **Robert T. Indrihovic** Advisor: J. Walker
Lattices, basis reduction, and the shortest vector problem.
May 1990

209. **Ira Amado** Advisor: Richman
Explicit generators of the invariants of finite groups and the invariants of UUT(n,F).
August 1990

210. **Neil D. D'Souza** Advisor: Jawerth
Rapid evaluation of potential fields in particle systems.
August 1990

211. **Gary C. De la Pena** Advisor: Schep
Rearrangement of series in normed spaces.
August 1990

212. **Jayasiri P. Deshabandu** Advisor: Schep
Zero-two law in Banach lattice algebras.
August 1990

213. **Chih-Chuan Fu** Advisor: J. Walker
A fast parametric maximum flow algorithm.
August 1990

214. **Nathan Hall** Advisor: Jawerth
C_0^∞ *and the phi-transform*.
August 1990

215. **Somasundaram Velummylum** Advisor: Howard
The calculus of variations and Zoll surfaces.
August 1990

216. **Xiaohua Hu** Advisor: D. Walker
The FCT algorithm on the Stardent Titan II computer.
December 1990

217. **Mahmoud A. Breigheith** Advisor: D. Walker
Fourier analysis and cyclic reduction : FACR.
May 1991

218. **Louis Kenneth Reinitz** Advisor: Howard
The periodic symmetry groups of the plane.
May 1991

219. **Dingguo Yin** Advisor: Markham
A basic inequality for singular values of the Matrix Hadamard product.
May 1991

220. **Gary Allan Cohen** Advisor: Howard
Intersection theory.
August 1991

221. **Enzhong Fu** Advisor: Markham
The eigenvalues and diagonal elements of a positive definite matrix.
August 1991

222. **Celeste C. Harter** Advisor: McNulty
Universal terms.
August 1991

223. **Joshua Fredie Kambira** Advisor: Sharpley
Some mathematical models of the growth of two species sharing a common environment.
August 1991

224. **Dianne L. Strong** Advisor: Markham
A brief survey of totally non-negative matrices.
August 1991

225. **Dongguang Wang** Advisor: Johnson
Sparse quasi-Newton updates for systems of nonlinear equations.
August 1991

226. **Farah Lourdes S. Marasigan** Advisor: J. Walker
Matroids and rigidity of structures.
May 1992

227. **Nancy Eugenia O'Dell-Warren** Advisor: Johnson
A comparison of gradient methods in nonlinear optimization.
May 1992

228. **Sam Nathaniel McDonald** Advisor: J. Walker
Stable matching problems in two and three dimensions.
August 1992

229. **Der-Shyong T. Chang** Advisor: Jawerth
Kernel operators and wavelets : numberical results.
August 1992

230. **Mary Margaret Hoy** Advisor: Johnson
Parallel computation issues in the factorization of sparse linear systems.
August 1992

231. **Pingshan Li** Advisor: Sharpley
Numerical solutions for the unsaturated flow equation.
August 1992

232. **Sharon Renee Morris** Advisor: Sumner
Graphs with small forbidden trees.
August 1992

233. **Hong Qi** Advisor: Johnson
Modeling of the failure processes of composite materials.
August 1992

234. **Abdollah Rabieh** Advisor: DeVore
A comparison of algorithms for curve generation.
August 1992

235. **Ayan Sengupta** Advisor: Johnson
Local convergence of quasi Newton methods using inexact gradients.
August 1992

236. **Thomas W. Simpson** Advisor: Bennett
The Airy integral and surface waves on water.
August 1992

237. **Fang Yao** Advisor: Bennett
Chaotic dynamical systems.
August 1992

238. **Yanbing Yu** Advisor: Bennett
Stationary phase and Kelvin's ship wake problem.
August 1992

239. **Bonnie Kelly** Advisor: Jawerth
Wavelet theory, multiresolution analysis, and the relationship between magnitude and location of different wavelets.
December 1992

240. **Kelly K. Chappell** Advisor: Yang
Automorphism group of the unit disc.
May 1993

241. **Andre Kuendgen** Advisor: Hudson
On the soluability of $\phi(x) = n$.
May 1993

242. **Patty L. Price** Advisor: Bennett
Inverse scattering and the Korteweg-deVries equation.
May 1993

243. **Richard A. Stewart** Advisor: Sumner
Critical concepts in the domination of graphs.
May 1993

244. **Tomas Dvorak** Advisor: Markham
On some conjectures on the chromatic index of hypergraphs.
August 1993

245. **Luke J. Olszewski** Advisor: Sharpley
A parallel approach to a one dimensional flow equation.
August 1993

246. **Jing Xu** Advisor: Bennett
The stability of solitary waves for the Korteweg-de Vries equation.
August 1993

247. **Mohamed A. Al-Lawatia** Advisor: Sharpley
Coupled nonlinear multicomponent transport equations.
May 1994

248. **Sofia M. Gervas** Advisor: Bennett
Inverse scattering and the sine-Gordon equation.
August 1994

249. **Kevin M. Jenerette** Advisor: Bennett
Inverse scattering and the nonlinear Schrodinger equation.
August 1994

250. **Deborah S. McConahay** Advisor: Sumner
A study of n*-extendable graphs.*
August 1994

251. **Fuming Wu** Advisor: Sharpley
Multiresolution analysis and some applications.
August 1994

252. **Yuxia Yuan** Advisor: Bennett
The wavelet transform and image processing.
December 1994

253. **Albert L. Bessey** Advisor: Sharpley
Parallelizing the lagrangian particle dispersion model.
May 1995

254. **Jen-Yin Han** Advisor: Griggs
The k*-choosability of a graph.*
May 1995

255. **Christopher R. Balcerek** Advisor: Johnson
The performance of a parameter identification algorithm for ordinary differential equations.
August 1995

256. **Willis C. Gorthy** Advisor: Johnson
Application of parameter identification for ordinary differential equations to numerical solution of the generalized Korteweg-de Vries equation.
August 1995

257. **Patrick Wesley Harley** Advisor: Filaseta
On a generalization of an irreducibility theorem of I. Schur.
August 1995

258. **Rishiparna Rehana Patel** Advisors: Nyikos and Wu
Continuous functions in the topology of pointwise convergence and classification of spaces.
August 1995

259. **Catherine Piellusch-Castle** Advisor: Sumner
The derivation, implementation, and comparison of artificial boundary conditions for the Helmholtz equation.
August 1995

260. **Anita Szombathelyi** Advisor: Markham
The maximal and minimal traces of (0,1)-matrices.
August 1995

261. **Shannon McFaul Smith** Advisor: Filaseta
An algorithm of Lenstra, Lenstra, and Lovasz.
December 1995

262. **Teresa Anne Caron** Advisor: Johnson
Splitting methods for solutions to structured systems of nonlinear equations.
May 1996

263. **Laszlo Zsilinszky** Advisor: Nyikos
Polishness of the Wijsman hyperspace topology.
August 1996

264. **Donald O. Adongo** Advisor: Wang
The numerical simulation of linear first-order hyperbolic equations.
December 1996

265. **Gerald W. Baygents** Advisor: Filaseta
Reducibility critereon in polynomials with nonnegative coefficients.
December 1996

266. **Eric David Sinzinger** Advisor: Jawerth
Fast object recognition using wavelet based curvature signatures.
December 1996

267. **Alexsei S. Telyakovskii** Advisor: Wang
A Runge-Kutta Eulerian-Lagrangian localized adjoint method for advection-reaction equations.
December 1996

268. **Turker Teker** Advisor: Hudson
A k-th power analogue of a classical theorem on quadratic residues.
May 1997

269. **Brian Dalpiaz** Advisor: Griggs
The assignment problem and three efficient algorithms.
August 1997

270. **Brian Charles Hipp** Advisor: Filaseta
A variation on a theorem of Ljunggren.
August 1997

271. **Justin H. Clouser** Advisor: Sumner
The chromatic number of a graph with respect to its clique size.
August 1998

272. **Mihaela-Rodica Cornea** Advisor: Jawerth
Nonlinear curve approximation and hierarchical shape representation.
August 1998

273. **Charles Judge** Advisor: Hudson
The Jacobi symbol $(-4n/a)$ *in subintervals of* $(0, 2n)$ *and the class number of the imaginary quadratic field* $\mathbf{Q}(\sqrt{-n})$.
August 1998

274. **Sophia Denise Waymyers** Advisor: Markham
Some characterizations of majorization.
August 1998

275. **James Blair** Advisor: Filaseta
Determining irreducibility of polynomials through the use of Newton polygons.
December 1998

276. **Edward E. Johnson** Advisor: Nyikos
Classification and completeness of quasi-metrizable spaces.
December 1998

277. **Shangrong Cai** Advisor: Bennett
The lifting scheme for biorthogonal wavelets.
May 1999

278. **Sherry A. Leschinsky** Advisor: Stoll
Hardy spaces of higher order.
May 1999

279. **Szilard Bokros** Advisor: Szekely
Implementing the short quartet methods.
August 1999

280. **Jiangguo Liu** Advisor: Wang
A wavelet scheme for linear advection equations.
August 1999

281. **John F. Riggott** Advisor: Ford
The distribution of the abundant numbers.
August 1999

282. **Michael Karl Wackerfuss** Advisor: Trifonov
Exponential divisors and exponentially square-free integers.
August 1999

283. **Mark W. Whisler** Advisor: Dix
Large-time asymptotics of solutions to the non-homogeneous heat equation.
August 1999

284. **Aseem Raval** Advisor: Howard
Mathematics related to spinning tops.
December 1999

285. **Keith H. Morris** Advisor: Griggs
An analysis of k*-sums on* N*-wheels.*
August 2000

286. **Michael S. Venn** Advisor: Howard
Analysis on finite Gel'fand spaces.
May 2001

287. **Paul Summer Akers** Advisor: Griggs
Minimum upper bounds on 2-colored Ramsey numbers.
August 2001

288. **Phillip Bushkar** Advisor: Trifonov
P-adic numbers and quadratic forms.
August 2001

289. **Joseph P. Patterson** Advisor: Dilworth
An extension of Elton's ℓ_1^n *theorem to complex Banach spaces.*
August 2001

290. **Ellison Anne Williams** Advisor: Nyikos
A forty-one year problem : Does $M_3 \Rightarrow M_1$ *?.*
August 2001

291. **Michael Peretzian Williams** Advisor: Filaseta
Eisenstein's criterion applied to m^{th} *order Bernoulli polynomials of degree* m*.*
August 2001

292. **Yabin Ding** Advisor: Wang
An upwind-shifting finite volume scheme for advection-diffusion equation.
May 2002

293. **Mutlu Battaloglu** Advisor: Wang
Modeling and simulation to European option pricing.
May 2002

294. **Shuang Li** Advisor: Wang
A discontinuous Galerkin method for the Black-Scholes equation arising in financial mathematics.
August 2002

Appendix VI: The Department's Tenure and Promotion Document

Department of Mathematics
University of South Carolina

Criteria and Procedures Regarding Promotion and Tenure For Mathematics Faculty

Approved by Unanimous Vote
of the
Committee of Tenured Mathematics Faculty
At its Meeting of
March 5, 1990

Amended in Consultation with the Mathematics Faculty
and the
University Committee on Tenure and Promotions
and
Approved by the Latter Committee
at its
Meeting of July 9, 1990

Criteria and Procedures Regarding Promotion and Tenure For Mathematics Faculty

I. Introduction

A.Responsibility for Formulation and Evaluation.

The primary responsibility for formulating criteria and procedures for promotion and tenure of mathematics faculty rests with the tenured mathematics faculty. The criteria and procedures shall be compatible with the rules and policies set by the Board of Trustees (see the University of South Carolina Faculty Manual and by the Dean of the College of Science and Mathematics (see College of Science and Mathematics Policies and Procedures D.4.011-Promotion of Faculty Members and D.4.012-Tenure of Faculty Members). The tenured mathematics faculty also have the responsibility for the periodic evaluation of these criteria and procedures, and for implementing modifications as deemed necessary. In both the formulation and evaluation phases, input will be obtained from all tenured and tenure-track mathematics faculty. All faculty shall be informed of any modifications in the criteria or the procedures.

B.Utilization of Criteria and Procedures.

The recommendations of the tenured mathematics faculty regarding promotion and tenure shall be based on the criteria and will be made according to the procedures detailed in this document. The criteria for promotion and tenure will also be used by the appropriate tenured mathematics faculty as a basis for annual peer review. In addition, the criteria will serve as a basis for the annual faculty evaluation conducted by the Department Chairman. The criteria are intended to ensure that these recommendations and evaluations are made in an objective manner and are based solely on professional merit. In no event shall a negative decision on promotion or tenure be based upon discrimination resulting from the candidate's race, sex, religion, or national origin, the exercise by the candidate of his constitutional rights, or personal malice. Where appropriate, the use of any gender in this document shall be understood to include any other gender.

C.Standards and Goals.

The criteria for promotion and tenure reflect the mathematics faculty's goal of achieving excellence in its research and educational programs. The criteria are not only representative of the accomplishments of the current faculty, but are also an indication of their desire to make even greater progress in the future. The criteria have been formulated on the premise that each faculty member's performance can be subdivided into the areas of research, teaching, and service. Considerable variation is to be expected among the faculty in their performance in each of these areas, but it is recognized that each of these areas is an essential ingredient in the professional profile of a mathematician at the university level.

II. Criteria for Promotion and Tenure

A. General Criteria.

Evaluation of a candidate for promotion or tenure will include assessments of the candidate's record in research, teaching, and service. The cumulative record includes documented evidence of the candidate's research, teaching, and service activities at the University, as well as at other universities and research organizations. Earlier assessments of these activities (such as the annual peer reviews of the candidate's progress toward promotion and/or tenure) are also considered part of the record. The basis of the review will be described in the paragraphs that follow.

In the paragraph below "the committee" refers to the appropriate committee of tenured faculty which is fully described in Section III of this document.

Evaluation of research and scholarly activities is based primarily on quality, although evidence of sustained activity is also essential. Among the evidence considered in judging a candidate's record in research are refereed publications and other researchers' citations and reviews of them, external grant funding, invitations to conferences and symposia, colloquium invitations, research books and monographs, editing of journals or of research books, refereeing and reviewing activity, direction of theses, development of and participation in departmental seminars, and other indicators of scholarly achievements. Additionally, a candidate's research will be evaluated by recognized experts in his area from outside the University, and their confidential appraisals of his research will be weighed heavily. To the extent possible, a candidate's achievements in research and scholarship will be compared with the achievements of persons at other universities whose standing is comparable to that of the University of South Carolina in the national research community.

A candidate's record in teaching will be assessed in a variety of ways. Classroom instruction, supervision of undergraduate and graduate research, seminar presentations, curriculum development, and contributions made to qualifying and comprehensive examinations are important aspects of a candidate's record in teaching. His record in instruction will be assessed on the basis of his ability to communicate mathematical concepts effectively to different audiences at various levels, to organize the material into coherent courses, to motivate students, and to maintain reasonable standards in grading. The cumulative record of student teaching evaluations and all peer evaluations of the candidate's teaching on record with the Department faculty will be used to assess classroom performance. A candidate may submit additional documentation (examinations or syllabi, for example) as evidence for those aspects of teaching that may not be apparent in the classroom.

To assess a candidate's record in service, the committee will consider his efforts in committee work, student advising, curriculum development, administrative duties, recruiting, and other activities in support of the educational and research programs at the department, college, and university levels. A candidate's role in service outside the University such as service on editorial boards and review panels, participation in professional societies, and organization of conferences and symposia will also be considered. Similarly, those aspects of a candidate's public or community service, which relate directly to his academic or scholarly responsibilities, will be considered. In the overall evaluation of a candidate's record in service, such qualities as initiative, industry, reliability, and effectiveness will be considered.

B. Criteria for Promotion.

A candidate for promotion must have professorial rank and be in a tenure-track or tenured position. A person who does not already hold such a position may, however, be appointed to a tenure-track or tenured position with professorial rank.

1. Criteria for Promotion to Associate Professor.
   a. A strong record in research and scholarly accomplishments.
   b. A record of effective teaching.
   c. A record of effective service.

   An exceptionally strong record in research can compensate for a lesser but still good record in teaching and service.
2. Criteria for Promotion to Full Professor.
   a. A very strong record in research and scholarly accomplishments with evidence of impact, recognized at the national and international levels, in the candidate's field.
   b. A strong record of effective teaching, with evidence of major contributions to the undergraduate and graduate programs.
   c. A strong record of effective service.

   An exceptionally strong record in research may offset a lesser but still good record in teaching and service. An exceptionally strong record in teaching and service, exhibiting a major impact on the Department, can offset a lesser but still strong record in research.

C. Criteria for Tenure.

A candidate for tenure must have professorial rank and be in a tenure-track position. A person who does not satisfy these requirements may, however, be appointed to a tenure-track or tenured position with professorial rank. Recommendations for tenure are made on the basis of proven performance in research, teaching, and service.

1. Criteria for Tenure of an Associate or Full Professor.
   a. A candidate must satisfy all of the criteria for promotion to his current rank.
   b. A candidate's record must provide evidence of the consistency and durability of his performance in research, teaching, and service.
2. Criteria for Tenure of an Assistant Professor.
   a. A candidate must satisfy all of the criteria for promotion to associate professor. In particular, an assistant professor will not be recommended for tenure unless he is simultaneously recommended for promotion.

b. A candidate's record must provide evidence of the consistency and durability of his performance in research, teaching, and service.

While length of service at the University can be a factor in determining the consistency and durability of a tenure candidate's performance, substantial prior experience or an exceptional record of accelerated contributions can play the same role.

D. Appointments with Tenure.

It is recognized that under certain circumstances, it may be in the Department's best long-range interests to make an appointment with tenure. Such a decision must be based on an assessment of institutional needs and resources and evidence of a candidate's potential for contributing to these needs. An appointment with tenure will be made only at the rank of associate or full professor.

III. Procedures for Promotion and Tenure

Note: At each point the procedures where a date is to be specified, the date is determined by the Tenure and Promotion Calendar for that year. Hereafter, these dates will be referred to as "the current calendar dates." It is to be noted that those faculty with mid-year appointments will not have the same dates as those faculty whose appointments began with a fall semester. These mid-year dates are included in the Tenure and Promotion Calendar.

A. Potential candidates for tenure and/or promotion will be advised in writing by the Department Chairman by April 15th concerning the timetable for the submission and consideration of tenure and/or promotion files for the coming academic year. This should provide each potential candidate with ample time to decide the question of candidacy and, for those electing candidacy, the opportunity to prepare a well-organized file.

B. Each promotion committee will consist of all tenured members of the faculty of the Department who have higher rank than that of a potential candidate. Each tenure committee will consist of all tenured members of the faculty of the Department of equal or higher rank than that of a potential candidate. By the last day of the spring semester classes, the Department Chairman will convene meetings of each committee for the purpose of electing chairmen to serve for the next academic year. These chairmen shall be nominated and elected by the appropriate committee, each member having one vote. The Department Chairman will report the names of those elected to chair the tenure and promotion committees to the Provost and to the Chairman of the University Committee on Tenure and Promotions by May 15th.

C. Each non-tenured faculty member who is in a tenure-track position but is not in the last year of a probationary appointment will be considered each academic year for tenure by the appropriate tenured faculty unless the faculty member requests that he not be considered. By the current calendar date, the Department Chairman will notify, in writing, each eligible faculty member that he/she will be considered for promotion and/or tenure must, by the current calendar date, so inform the Department Chairman in writing. For eligible faculty members not in the next to the last year of a probationary appointment, this action shall, not in any way, prejudice future considerations of the faculty member for promotion and/or tenure.

Note: Hereafter, a faculty member who will be considered for promotion and/or tenure is called a "candidate."

The tenure and/or promotion procedures for candidates other than the Department Chairman are described in items D through P below. Item P describes how these procedures are to be modified, in the event that the Department Chairman is a candidate.

D. By the current calendar date, each candidate for promotion and/or tenure must

1. Review and update his folder.
2. Submit to the Department Chairman a list of mathematicians from outside the University who are qualified to judge the candidate's mathematical research. This list should include a sketch of the qualifications of these individuals. At least five outside evaluators should be listed by candidates for promotion to or tenure as associate professors and at least six should be listed by candidates for promotion to or tenure as professor. Of the outside evaluators listed, no more than two may have had a close professional relationship with the candidate (dissertation advisor or post-doctoral supervisor are examples of close professional relationships).

E. In the event that any tenure or promotion committee has less than five members, the Department Chairman will notify the Dean of the College of Science and Mathematics. The Dean will consult with the members of the committee, the Department Chairman, and the candidates themselves. After this consultation, the Dean shall appoint the necessary number of tenured faculty of appropriate ranks from within the College of Science and Mathematics to increase the size of the committee to five.

Note: Hereafter, the committees defined in Items, C, D, or E will be referred to as the "appropriate tenured faculty."

F. A candidate may place any material he deems appropriate in his folder at any time before the unit vote. The following are items normally included in the file. This list should not be construed as being exhaustive or as placing priorities on any of these items. This list is given merely as a guideline.

1. A current biography.
2. A list of publications, papers accepted for publication, and papers submitted for publication.
3. Reprints of publications and copies of manuscripts accepted or submitted for publication.
4. A list of talks at professional meetings and colloquia presented at the University or other institutions.
5. A list of courses taught.
6. A list of graduate students who are receiving or have received thesis direction under the candidate.
7. Teaching evaluations by students
8. Reports by faculty on classroom performance.
9. Information concerning refereeing and review assignments.
10. Information concerning other activities such as University or departmental committee work, student advisement, activities in professional societies, consulting, and other University and/or public service.

Apart from the items described explicitly in the paragraphs below or elsewhere in the University's procedures for promotion and tenure, only the candidate, the Department Chairman, and the Dean of the College of Science and Mathematics are permitted to insert material into the tenure or promotion file.

G. At any time before his folder is forwarded to the Dean of the College of Science and Mathematics, a candidate may decline in writing to be considered further. For candidates not in the next to the last year of a probationary appointment, this action shall not in any way prejudice further consideration of the faculty member for promotion and/or tenure.

H.

1. Lists of candidates for promotion and/or tenure are distributed by the Department Chairman to the appropriate tenured faculty and the Dean of the College by the current calendar date. The committee chairmen shall give timely prior notification of all pending meetings of their committees to the candidate, the Department Chairman, and the Dean of the College of Science and Mathematics.
2. The chairman of the appropriate committee will appoint a subcommittee to draft a summary and interpretation of the documented evidence of the candidate's teaching performance. The written report of this subcommittee will take into account all available student teaching evaluation summaries and all peer evaluations of the candidate's teaching on record with the Department. Prior to the preliminary vote, described in H (3) below, and with the written draft report of the subcommittee available, the appropriate committee of tenured faculty will adopt, by majority vote, a statement summarizing and interpreting the candidate's performance as a teacher. This statement will normally include judgments of the quality of the candidate's teaching; it will, therefore, be treated as a confidential letter of evaluation not to be disclosed to the candidate, and it will become part of the candidate's file at the time of the final unit vote.
3. The file of a candidate for promotion and/or tenure will be given a preliminary review by the appropriate tenured faculty, and by the current calendar date the appropriate tenured faculty will meet and vote by secret ballot on whether the candidate should be considered further. The chairman will inform the candidate of the vote count in writing. If fewer than half of the votes cast by the appropriate tenured faculty are favorable (abstentions not counted), and the candidate is not in the next to last year of probationary appointment, then the candidate will not be considered further for promotion and/or tenure at this time, unless he informs the chairman in writing that he requests a complete review. A candidate who is in the next to the last year of a probationary appointment will receive a

complete review unless he informs the chairman in writing that he wishes to withdraw from further consideration.

4. By the current calendar date, for each candidate who is to be considered further, the chairman will write to the required number of evaluators outside the University soliciting evaluations of the candidate's record; the chairman may also request a curriculum vita from each of these outside evaluators. At least three of these evaluators must come from the candidate's list. The other evaluators are to be selected by the chairman with consultations as necessary. A total of five evaluators is required for promotion to or tenure as an associate professor and a total of six is required for promotion to or tenure at the level of full professor. The replies, when received, are to be made available to the committee, and will be placed in the candidate's folder at the time of the unit vote by the chairman.

I.

1. By the current calendar date, the appropriate tenured faculty, having reviewed each candidate's folder including the outside evaluations, will meet and vote by secret ballot on whether or not the candidate is to be recommended for promotion and/or tenure. A candidate is to be recommended if and only if at least 2/3 of the votes cast by the appropriate tenured faculty are favorable (abstentions not counted). The ballots will go into the candidate's file. In a timely fashion, the chairman will notify each candidate in writing of the decision of the appropriate tenured faculty.
2. A candidate may elect at this time to withdraw from further consideration for promotion and/or tenure; in this case, the faculty member must inform the chairman of his decision in writing within one week of his notification. If the candidate is not in the next to last year of a probationary appointment, this action shall in no way prejudice further consideration of the faculty member for promotion and/or tenure.
3. If the candidate is dissatisfied with the decision of the appropriate tenured faculty and wishes to appeal by the current calendar date, he must notify the chairman in writing. By the current calendar date, the chairman will call a meeting of the appropriate tenured faculty to consider the candidate's appeal. A record of the deliberations of the appropriate tenured faculty will be placed in the candidate's folder.
4. After the unit has voted, only these items may be added to the file:
   a. Unit vote justifications and letters from the Department Chairman, the Dean and the Provost accompanying the file to the next steps of the procedure.
   b. The votes and recommendations of the University Committee on Tenure and Promotions.
   c. Material information arising as a consequence of actions taken prior to the unit vote, for example (i) letters from outside evaluators solicited before but received after the unit vote; (ii) notification of acceptance of a manuscript referred to in the file; (iii) publication of books or articles which had been accepted prior to the unit vote; and (iv) published reviews of the candidate's work which appeared after the unit vote.
   d. Letters from faculty members of the unit. Each faculty member, whether or not authorized to vote, may write to the Department Chairman or to the Dean. Such letters will become part of the file at the addressee's level.

In order for new information to be included in the file, voting members of the unit, the Department Chairman, the Dean, and the provost must be informed of its existence and given a chance to assess it and reconsider their previous votes.

J. By the current calendar date, either:

1. A letter indicating that the candidate is recommended by the appropriate tenured faculty will be placed in the folder of the candidate. The letter will be drafted by a subcommittee of at most three members of the appropriate tenured faculty and is subject to approval by the appropriate tenured faculty. The letter should include a statement of the rationale for supporting the candidate, summarized from the comments on the ballots and discussion during the meeting (see III.I.1), and a record (including abstentions) of the vote. Or
2. A letter indicating that the candidate is not recommended by the appropriate tenured faculty will be placed in the folder of the candidate. The letter will be drafted by a subcommittee of at most three members of the appropriate tenured faculty and is subject to approval by the appropriate tenured faculty. The letter should include a statement of the rationale for not supporting the candidate,

summarized from the comments on the ballots and discussion during the meeting (see III.I.1.), and a record (including abstentions) of the vote. The decision of the appropriate tenured faculty not to recommend the candidate shall in no way prejudice further consideration of the faculty member for promotion and/or tenure. A candidate will not be considered further for promotion and/or tenure at this time unless he informs the Department Chairman in writing that he requests that his folder be forwarded to the Dean.

K. A final list of candidates, whose folders will be forwarded to the Dean of the College of Science and Mathematics, will be distributed by the Department Chairman to all faculty by the current calendar date.

L. Each appropriate tenured faculty member must write a letter explaining his position concerning the promotion and/or tenure of those candidates whose folders will be forwarded to the Dean of the College of Science and Mathematics. These letters will be sent directly to the Dean of the College so that they are received by the Dean's office no later than the current calendar date.

M. The Department Chairman will put in writing his recommendations concerning each candidate. In the event that the vote of the appropriate tenured faculty committee on any candidate was either favorable or unfavorable by a margin of one vote or less and the Department Chairman was a member of the appropriate tenured faculty committee, the Department Chairman must include this information in his recommendation. The Department Chairman's recommendation will be placed in the candidate's tenure and promotion file and from this point on, no member of the Department, other than the Department Chairman, will read the file. By the current calendar date, the tenure and promotion file of each candidate will be submitted to the Dean of the College of Science and Mathematics.

N. The procedures for hiring personnel with tenure will follow the guidelines set forth by the University policies and procedures.

O. If a candidate being considered for promotion and/or tenure is currently the Chairman of the Department, the responsibilities assigned to the Chairman under items B, H (4) and J shall be performed by the chairman of the appropriate faculty committee. All other responsibilities assigned by the procedures above to the Department Chairman shall be carried out by him except item M. The file shall be submitted to the Dean of the College of Science and Mathematics by the committee chairman, by the current calendar date.

Appendix VII: Post-Tenure Review Document

Post-Tenure Peer Review of Faculty Performance

Department of Mathematics

1. Statement of General Purpose

To carry out its principal missions the Department of Mathematics requires a faculty comprised of individuals who together embody a wide array of knowledge, talent, abilities, and personal skills. This faculty, working together, must be able to provide instruction leading to an assortment of undergraduate and graduate degrees; it must be able to foster the advance of mathematics, to conserve the best fruits of those advances, and to disseminate mathematics and facilitate its applications. This faculty, working together, must also do its part in supporting the University and the profession.

The purpose of the in-depth peer review of faculty performance is to help ensure that the faculty, as a whole, is able to carry out the mission of the Department, to recognize and reward faculty members whose performance is of exceptionally high quality, and to identify weaknesses and offer assistance to faculty members whose performance is in need of improvement.

Individual faculty members contribute differing abilities to the Department's pool of talent. The success of the Department depends on being able to make appropriate effective use of all these differing individual abilities in teaching, research and service. Over the course of an individual faculty member's career these abilities change, as does the distribution of time and effort the faculty member might best devote to the various aspects of his or her position. The criteria for satisfactory performance have been framed to accommodate this wide variation—a variation not only to be expected, but one the Department needs in order to carry out its principal missions.

Nothing in this document shall be construed to constrain the academic freedom of individual faculty members to pursue their research or scholarly enterprises in the directions and by the means they choose according to their own best judgment. Nor should anything here be construed to constrain the academic freedom of individual faculty members in their roles as teachers.

These procedures and criteria for post-tenure peer review of faculty performance will be consistent with, and incorporate, the regulations and procedures of the University, as described in the Faculty Manual, and of the College of Science and Mathematics.

2. Faculty Subject to Review

The performance of every tenured member of the faculty of the Department of Mathematics will be reviewed in-depth at least once every six years, except that such a performance review will be waived for any faculty member who notifies the Department Chair in writing of retirement or resignation within three years of the next scheduled review. In the event that the Department Chair comes under in-depth review according to the six-year time table, the in-depth review will not be carried out according to the procedures in this document, but will instead be performed by the Dean of the College in consultation with the Department. In this case, the Chair of the In-Depth Peer Review Committee will notify, in a timely fashion, both the Dean and the Department Chair that the Department Chair is due for an in-depth peer review.

The performance reviews involved in candidacies for promotion and for tenure, which have been supported at the unit level, as well as those for appointment or retention as a chaired professor are in-depth performance reviews. The appropriate unit Tenure and Promotion Committee will also make a determination of whether the candidate's performance is superior, satisfactory, or unsatisfactory according to the criteria in this document. In the event of a finding of "superior" or "satisfactory" performance, these findings will be forwarded to the Department Chair to be acted on further as described in this document. In the event a finding of "unsatisfactory performance" be made, the case will be placed in the hands of the In-Depth Peer Review Committee to be acted on as described in this document for cases that result in overall unsatisfactory findings.

Beginning in the Fall of 1999, roughly one sixth of the tenured faculty, in order of seniority since their most recent in-depth performance review, will be reviewed each year.

3. Criteria

The performance of a faculty member will be evaluated in each of the areas of teaching, research and scholarship, and service.

Criteria for Teaching

Superior: A finding of superior performance in teaching (including advising students) is appropriate in a variety of circumstances.

At the undergraduate level such a finding could be based on any of the following:

- Highly effective classroom teaching.
- Sustained and well-regarded work as a mentor of undergraduates. A few examples of such mentor roles include involvement in Preston College, in the Honors College, with ΠME, and coaching teams of undergraduates in regional and national competitions.
- Public recognition of excellent teaching. Such recognitions may take the form of nominations for or the actual achievement of an award for teaching or advising.

At the graduate level such a finding may be based on any of the following:

- Sustained organization and operation of a research seminar for graduate students.
- Thesis or dissertation supervision of several graduate students simultaneously.
- Supervision of a Ph.D. dissertation which has attracted national recognition.

Satisfactory: Satisfactory teaching includes effective instruction in the classroom and during office visits by students.

Unsatisfactory: A record of repeated and continuing ineffective teaching will be deemed unsatisfactory.

Criteria for Research and Scholarship

Superior: A finding of superior performance in research and scholarship is appropriate in a variety of circumstances.

Superior research accomplishments will generally have attracted the acclaim of the national or international community of mathematicians working in the same area as the faculty member under review. Work that is well regarded, widely known, and cited often in the literature by other members of such a community should be deemed superior. A few indicators of superior research accomplishment include the following: judgment of external evaluators, international or national awards or prizes, the award of external funding for research, selection for national or international fellowships, invitations to address international conferences, and invitations to speak at research institutions.

Some indicators of superior scholarly accomplishments in mathematics include the publication of widely used textbooks, the publication of widely read expository books or articles, and invitations to give expository addresses at national conferences or at colleges and universities.

Satisfactory: A faculty member's performance in research and scholarship will be deemed satisfactory on the basis of a demonstrated record of sustained effort to broaden and deepen the faculty member's grasp of mathematics and to advance the frontiers of knowledge. Indicators of satisfactory performance in research and scholarship include research and expository publications, award of external funding to support research or scholarship, participation in research seminars, addresses given at conferences, colloquium and seminar presentations, teaching courses on topics of current research interest, and other activities that indicate that the faculty member has a sustained, deep, and vital command of a substantial part of mathematics.

Unsatisfactory: A faculty member's performance in research and scholarship will be deemed unsatisfactory if the record fails to demonstrate a sustained effort to develop a broader or deeper understanding of mathematics, or fails to demonstrate a sustained effort to communicate such an understanding.

Criteria for Service

Superior: A finding of superior performance in service is appropriate in a variety of circumstances.

For service within the University such a finding could be based on any of the following:
- appointment or election to positions of trust or of authority or ones demanding heavy commitments of time and effort.
- Innovative service that displays initiative and persistence, and effectively supports the mission of the University.

For professional service outside the University such a finding could be based on any of the following:
- Service on editorial boards.
- Service on national panels.
- Service on the committees of or as officers of the several professional organizations of mathematicians.
- A sustained record of service on the organizing or program committees of national and international mathematical conferences.
- A record of organizing effective programs aimed at promoting mathematics in the larger community.

Satisfactory: A faculty member's performance in service within the University will be deemed satisfactory if the faculty member willingly takes on assigned service roles and carries them out reliably and effectively.

Unsatisfactory: A faculty member's performance in service will be deemed unsatisfactory if that member's record shows repeated unwillingness to carry out assigned service roles, or if the record shows repeated unreliability or ineffectiveness in these roles.

4. Files

Every faculty member subject to in-depth peer review will assemble a file to submit to the In-Depth Peer Review Committee. The file must contain a cumulative curriculum vitæ prepared by the faculty member which summarizes that member's professional career. In addition, the file should have separate sections devoted to the faculty member's teaching, research and scholarship, and service. These sections may be cumulative for the whole career of the faculty member, but they should focus on the period since the last in-depth peer review. Each section should begin with a summary. The section on teaching should include all the teaching evaluation summaries for the period since the last in-depth review. Copies of all publications, except those of book length, for the period since the last in-depth review should be included in the section on research and scholarship. The faculty member may include any other evidence or information in the file which may be relevant to the review process.

After it is submitted to the In-Depth Peer Review Committee, the file shall be held confidential.

The In-Depth Peer Review Committee shall insert into the file all the following documents on record in the Department for the period since the last in-depth review:
- all annual peer review letters,
- all joint letters concerning teaching by tenured full professors that have been prepared according to the Department's Peer Review of Teaching Policy,
- all administrative reviews, and
- all reports of the results of sabbatical leaves.

In order to clarify its evaluation, the In-Depth Peer Review Committee may, at its discretion, seek letters from external reviewers to assess the mathematical research and scholarship of a faculty member under review. In all cases where the faculty member under review has not had a significant record of refereed publications in print or in press since the last in-depth review, the In-Depth Peer Review Committee will solicit such letters. In the event that the In-Depth Peer Review Committee seeks letters, they must be sought from at least two different external reviewers. These letters will be included in the file.

5. The In-Depth Peer Review Committee

The In-Depth Peer Review Committee shall consist of five tenured faculty members, three of whom must hold the rank of full professor. By the end of each Spring semester, the tenured members of the faculty of the Department shall elect a Chair for the In-Depth Peer Review Committee, who must be a tenured full professor, and such other members of the tenured faculty as needed to serve as the members of the In-Depth Peer Review Committee. Except in the first year of operation, the term of service on the In-Depth Peer Review Committee will be two years. In the first year of operation, the Committee Chair and one other full professor will be elected to one year terms, while the remaining three committee members will be elected to two year terms. None of these five committee members should themselves be subject to the in-depth peer review process during their service on the committee. The Department Chair shall not serve on the In-Depth Peer Review Committee. In the event that a vacancy occurs on the committee, the Chair of the Department's Tenured Faculty shall convene a meeting of the tenured faculty to elect a replacement. Should the Department have an insufficient number of faculty members qualified to complete the committee, the Department Chair, with the approval of the Dean, shall appoint qualified members of the faculty of the College to complete the committee.

6. Procedures

The In-Depth Peer Review Committee will complete each submitted file, soliciting external letters, if appropriate. Based on their review of the evidence in the completed file, the committee will determine by majority vote, no abstentions allowed, for each of the areas of teaching, research and scholarship, and service, whether the performance is superior, satisfactory, or unsatisfactory according to the criteria described above.

An overall finding of superior performance will be made if the faculty member's performance in two of the three areas has been found superior and the performance in the remaining area is at least satisfactory. An overall finding of unsatisfactory performance will be made if the faculty member's performance in teaching or in both of the other areas has been found unsatisfactory. In all other cases, an overall finding of satisfactory performance will be made.

The In-Depth Peer Review Committee will prepare a detailed written report on each faculty member who is subject to review, supporting its findings. The written report will be inserted into the file, and the complete file will be delivered to the Department Chair. A copy of the written report will be provided by the Department Chair to the faculty member who is the subject of the review. The Department Chair should discuss the report and any recommendations of the committee with the faculty member.

The Department Chair will add a statement to the file of each faculty member under review, and deliver the files to the Dean of the College.

In the event that an overall finding of unsatisfactory performance has been made, the In-Depth Peer Review Committee will make written recommendations to remedy deficiencies or address problems, and offer a plan and assistance to the faculty member under review to improve performance in the deficient areas indicated by the review. This will constitute a three year development plan in which the faculty member must demonstrate annually substantial progress. The In-Depth Peer Review Committee is expected to assist faculty members in the successful completion of those plans. After three years have elapsed, the faculty member will be required to undergo the in-depth peer review process again. During the three year period, prior to each annual peer review, the Department Chair, in consultation with the In-Depth Peer Review Committee, will assess the progress of faculty members who are following three-year development plans. The written assessment of the Department Chair will be forwarded to the unit committee for promotion to full professor. That committee, as part of the annual peer review, will review the Department Chair's assessment and state in writing its concurrence or dissent, in general or in any particular. The Department Chair's assessment as well as the response of the Committee of Tenured Full Professors will be provided to the faculty member under review, and will also be sent to the Dean of the College.

7. Appeals

A faculty member under review who disagrees with any portion of the review or of the recommendations of the committee may request that the unit committee for promotion to full professor consider the case. The faculty member may provide a written rebuttal, with any supporting evidence, to the unit promotion committee. The findings of the unit promotion committee, together with its recommendations for action, the Department Chair's evaluation, the proposed development plan, and a statement by the faculty member will be forwarded to the Dean of the College for final determination.

8. Amendment of this Document

This document may be amended at any time by at least two-thirds (not counting abstentions) vote of the tenure-track and tenured faculty of the Department of Mathematics; the amended document is subject to approval by the Dean of the College of Science and Mathematics and by the Provost. A mathematics faculty member may choose to be reviewed under the Post-tenure Peer Review document in effect at the time of that faculty member's upcoming review or under any previous Post-tenure Peer Review document in effect since that faculty member's last such review.

Adopted by the Department of Mathematics 1 April 1999.

Appendix VIII: Departmental Brochures and Newsletters

Appendix IX: The Report of the 1985 External Review Panel