NOTICES
OF THE
AMERICAN MATHEMATICAL SOCIETY

1988 Annual AMS-MAA Survey  page 1301
Calendar of AMS Meetings and Conferences

This calendar lists all meetings which have been approved prior to the date this issue of Notices was sent to the press. The summer and annual meetings are joint meetings of the Mathematical Association of America and the American Mathematical Society. The meeting dates which fall rather far in the future are subject to change; this is particularly true of meetings to which no numbers have been assigned. Programs of the meetings will appear in the issues indicated below. First and supplementary announcements of the meetings will have appeared in earlier issues.

Abstracts of papers presented at a meeting of the Society are published in the journal Abstracts of papers presented to the American Mathematical Society in the issue corresponding to that of the Notices which contains the program of the meeting. Abstracts should be submitted on special forms which are available in many departments of mathematics and from the headquarters office of the Society. Abstracts of papers to be presented at the meeting must be received at the headquarters of the Society in Providence, Rhode Island, on or before the deadline given below for the meeting. Note that the deadline for abstracts for consideration for presentation at special sessions is usually three weeks earlier than that specified below. For additional information, consult the meeting announcements and the list of organizers of special sessions.

Meetings

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<tr>
<th>Meeting #</th>
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<th>Abstract Deadline</th>
<th>Program Issue</th>
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<td>847</td>
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<td>Phoenix, Arizona†</td>
<td>Expired</td>
<td>December</td>
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<td>848</td>
<td>* April 15-16, 1989</td>
<td>Worcester, Massachusetts</td>
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<td>March</td>
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<tr>
<td>849</td>
<td>* May 19-20, 1989</td>
<td>Chicago, Illinois</td>
<td>March 1</td>
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<td>850</td>
<td>August 7-10, 1989</td>
<td>Boulder, Colorado†</td>
<td>May 16</td>
<td>July/August</td>
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<td></td>
<td>(92nd Summer Meeting)</td>
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<td>October 21-22, 1989</td>
<td>Hoboken, New Jersey</td>
<td>August 16**</td>
<td>October</td>
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<td>October 27-28, 1989</td>
<td>Muncie, Indiana</td>
<td>August 16**</td>
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<td></td>
<td>January 17-20, 1990</td>
<td>Louisville, Kentucky</td>
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<td></td>
<td>(96th Annual Meeting)</td>
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<td></td>
<td>August 8-11, 1990</td>
<td>Columbus, Ohio</td>
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<td>(93rd Summer Meeting)</td>
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<td>January 16-19, 1991</td>
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<td></td>
<td>(97th Annual Meeting)</td>
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<td></td>
<td>August 8-11, 1991</td>
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<td></td>
<td>(94th Summer Meeting)</td>
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<td>January 8-11, 1992</td>
<td>Baltimore, Maryland</td>
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<td></td>
<td>(98th Annual Meeting)</td>
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<td></td>
<td>June 29-July 1, 1992</td>
<td>Cambridge, England</td>
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<td>(Joint Meeting with the London Mathematical Society)</td>
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<td>January 5-8, 1994</td>
<td>Cincinnati, Ohio</td>
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<td></td>
<td>(100th Annual Meeting)</td>
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*Please refer to page 1371 for listing of special sessions.

** Please refer to page 1371 for listing of special sessions.

† Preregistration/Housing deadline is November 10

‡‡ Preregistration/Housing deadline is June 1

Conferences


June 3–August 5, 1989: Joint Summer Research Conferences in the Mathematical Sciences, Humboldt State University, Arcata, California

July 10–30, 1989: AMS Summer Research Institute on Several Complex Variables and Complex Geometry, University of California, Santa Cruz, California

Deadlines

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<thead>
<tr>
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* Please contact AMS Advertising Department for an Advertising Rate Card for display advertising deadlines.

** For material to appear in the Mathematical Sciences Meetings and Conferences section.
ARTICLES

1301 1988 Annual AMS-MAA Survey  (First Report)
   The first report on the 1988 Survey includes a report on the 1988 survey
   of new doctorates, a report on salaries of new doctorates, salary and
   other data on faculty members in four-year colleges and universities,
   and a list of names and thesis titles for members of the 1987-1988 PhD
   class.

1350 For Your Information
   The highlights of the twelfth annual meeting of the International
   Group for the Psychology of Mathematics Education (PME) and the
   sixth quadrennial International Congress on Mathematical Education
   (ICME-6) are presented.

FEATURE COLUMNS

1333 Computers and Mathematics  Jon Barwise
   Stephen Wolfram's new software program, Mathematica, is previewed,
   with a major portion of the column devoted to a review of Mathematica
   by Eugene Herman. Additional brief comments on the program are
   made by individuals with their own special applications for Mathematica.

DEPARTMENTS

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Assistantships and Graduate Fellowships in the Mathematical Sciences, 1989-1990

For the last twenty-three years the December issue of the Notices has been devoted to information about assistantships and fellowships in the mathematical sciences. The "A&F" has developed into a valuable resource for prospective graduate students and their advisors.

As previously announced, starting in December 1988, the data will no longer appear in a special issue of the Notices, but will become a separate, stand-alone publication.

The information provided in the new publication will continue to be collected annually from departments of mathematics, applied mathematics, statistics and computer sciences as part of the Annual AMS-MAA Survey, under the direction of the Data Subcommittee of the AMS-MAA Committee on Employment and Educational Policy (CEEP). In addition to publishing the same vital information about current assistantships and graduate fellowships, the new identity and format will allow for future expansion. CEEP's goal is to expand in future years to provide a hybrid of the former Assistantships and Fellowships issue and the now defunct MAA Guidebook to Departments in the Mathematical Sciences (last published in the late 1970s), thus presenting an accurate and complete sketch of degree programs in the mathematical sciences from the bachelor's to the Ph.D.

Our aim is to distribute the new Assistantships and Graduate Fellowships so that it is available at the right time (December) for mathematical science departments, and so that it is widely available to both current and prospective members of the mathematical community. Multiple copies will be mailed to institutional member departments, to those departments listing information, to departments placing advertisements; it will be available to individual members at the usual member discount.

James W. Maxwell, Associate Executive Director, is organizing the new publication and will be happy to receive your comments and questions about the new version of this valued resource.

For more details, see this issue, page 1357.
Challenges for the Mathematics Community

Dr. Edward David’s address at the recent 100th anniversary celebration informed us of the significant progress in obtaining government funding for mathematics research and prodded us to even further efforts in the face of more difficult times. However, the challenge seems even much greater than Dr. David has indicated. A couple of points will illustrate this.

The basis for research, in the sciences as well as mathematics, is the individual investigator; large projects and specialized institute programs build on this base. The very small gains in the numbers of investigators receiving support and the sometimes arbitrary funding decisions cast a pall over the field which not only discourages senior researchers but creates an image that must turn away young people. No amount of emphasis on largeness will undo this damage. However, this misplaced emphasis, part of government policy, is now affecting other sciences and we have an opportunity to work with many scientists who have similar interest in small science. One goal might be to spin off a National Engineering Foundation—and with it many of the apostles of large science—from the Science Foundations and have a setup parallel to that of the National Academies of Science and Engineering.

We are also facing a tremendous drop in the number of first-rate researchers available to our universities. We continue to have reduced numbers of graduate students, despite very increased support for graduate students and postdocs. The nineties will see a great number of retirements, many more than can be replaced. There is every reason to expect a process of cannibalization (it has probably already started) which reduces the number of research departments (say of Group One status in AMS ratings) by half. As part of this we can expect an exodus of foreigners who have been so important to us. For example, while the European universities have been under tremendous difficulties, it is reasonable to expect that the combination of a large number of retirements, years of neglect for these universities, and a great economic boom (if the 1992 genuine common market occurs) will lead to a renaissance for European universities and many Europeans going home.

We must act and do so now.

Jonathan L. Alperin
The University of Chicago
(Received August 25, 1988)

Letters to the Editor

Policy on Letters to the Editor
Letters submitted for publication in Notices are reviewed by the Editorial Committee, whose task is to determine which ones are suitable for publication. The publication schedule requires from two to four months between receipt of the letter in Providence and publication of the earliest issue of Notices in which it could appear.

Publication decisions are ultimately made by majority vote of the Editorial Committee, with ample provision for prior discussion by committee members, by mail or at meetings. Because of this discussion period, some letters may require as much as seven months before a final decision is made.

Letters which have been, or may be, published elsewhere will be considered, but the Managing Editor of Notices should be informed of this fact when the letter is submitted.

The committee reserves the right to edit letters.

Notices does not ordinarily publish complaints about reviews of books or articles, although rebuttals and correspondence concerning reviews in Bulletin of the American Mathematical Society will be considered for publication.

Letters should be typed and in legible form or they will be returned to the sender, possibly resulting in a delay of publication.

Letters should be mailed to the Editor of Notices, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, and will be acknowledged on receipt.

EDITOR’S NOTE: The following letter, which first appeared in the October 1988 issue of Notices, is being reprinted. In the original printing, some of the points made by Professor Bergman were obscured by the typesetting method used for Notices. This occurred because the typesetting system TeX has a standard and uniform way of formatting the text which concealed the points Bergman wished to make. However, this error emphasizes the fact that uniformity is possible.

Uniform Style for Papers

As individuals many of us have, at times, had disagreements about style of typesetting and related questions with journals publishing our papers. Often we notice these problems when we are reading galley proofs, which is not a propitious time for working out differences; moreover, the production staff of a journal cannot always know whether some wish of an author is an individual quirk, or something that the mathematical community would agree about for good reasons. I therefore think it would be desirable if a discussion of such questions were begun among mathematicians (and members of the editorial staff of journals if they wish to participate), and the conclusions of this discussion passed on to the journals. This is not to ask that all journals adopt a uniform set of conventions; but we can hope that, knowing what we want and why, they will come up with styles closer to our needs.

Though the Society’s journals are not guilty of many of the faults I will mention, these Notices seem a good forum in which to bring up these questions.

It may be that computerized manuscript-production by authors will soon make the topic irrelevant. But at present, even if we have such facilities available, and produce a manuscript according to our own wishes, which we could in theory send to a camera-ready copy journal, considerations of field and backlog-time often lead to a different choice.

I mention below a few of my concerns, and hope that others will continue the discussion.
(1) In constructions such as $F_i = G_i \ (i = 1, \ldots, n)$, journals often run the condition "$(i = 1, \ldots, n)$" up against the preceding equation, with no intervening space. I think that their staff simply needs to be made aware that there is a distinction between functional constructions, such as $G_i(x_1, \ldots, x_n)$, and the above construction, in which the range of a variable is indicated following a formula. This latter, which calls for space before the parenthesis, can usually be recognized by the presence of predicate symbols, such as $=, \in$, etc. within the parentheses. When in doubt, the copy editor should look at the spacing in the manuscript.

(2) Many journals number displayed formulas on the right end of the line, while many of us have strong feelings that the numbers should go on the left. Probably the journals' reason is that they indent displayed formulas by a fixed amount, and an equation-number, which can occasionally be rather long, e.g. $(3.15 \ bis)$, might come uncomfortably close to the formula. However, to the mathematician it is natural to put the label on the left for the same reason that we write "Theorem 1" at the beginning of the statement of the Theorem rather than at the end. This is especially true when the display is not a formula, but a condition or an assertion, which may be more than one line long.

(3) Although it is preferable to choose our notation so as to minimize the use of second-order superscripts and subscripts, it is sometimes desirable to allow a couple of instances of these in a paper, rather than modifying the notation throughout for the sake of one or two points. Unfortunately, many journals set second-order superscripts and subscripts in almost illegibly small point-size. I think that the standard convention, that superscripts and subscripts are set three points smaller than the material they are attached to, is itself excessive. (I use a change of just one point-size in my own preprints and camera-ready material, with rare ad hoc exceptions when this looks insufficient.) I suspect that the three-point convention is a result of the fact that numerals are taller than lower-case letters, so that with less of a reduction, an expression like $x^2$ can appear top-heavy. The symbols that become illegible in second-order subscripts and superscripts are typically not numerals but lower-case letters. Even if the standard convention is followed for first order superscripts and subscripts, there should be a lesser reduction for the second-order case.

(4) Some journals could improve their choice of font-systems: characters with some strokes so thin that they disappear in a less-than-perfect photoreproduction, and script capital letters so elegant that it is hard to guess the letter intended, have particularly bothered me. In nontechnical use, such things are not serious faults because the surrounding letters in a word disambiguate the unclear letter, but for mathematical work they are a problem.

The above are points on which I think most of us will agree. I give below a few points that have troubled me, though I do not know whether others will feel the same way.

(5) It is standard for statements marked THEOREM, PROPOSITION, LEMMA and COROLLARY to be set in italics. Unfortunately, some journals stop there, and refuse to italicize the text of an item marked DEFINITION, CONJECTURE, etc., even if the authors request this. But I think the same considerations apply to these headings as to the former group: They introduce self-contained formal statements, which one wishes to set apart from the surrounding discussion in such a way that the reader can easily locate them when they are referred to, and see exactly where they begin and end.

(6) In typing mathematics, one often makes the separation between text and formulas more clear by leaving double spaces around symbols; e.g., around the "x" in

If the element $x$ has the above property . . ..

I have found it useful to extend this to typeset text. E.g., I prefer

If the element $x$ has the above property . . .

rather than

If the element $x$ has the above property . . ..

and suggest that this practice be made standard.

(7) I have begun adding my electronic mail address after the address line in my papers. It usually gets deleted by the copy editor, but I have usually succeeded in getting it restored in the galley proofs. Since such addresses are extremely convenient for communication, it would be valuable if their inclusion were considered normal.

Generally, journals should be tolerant of diversity of usage among authors, though there must be a balance between this and their need to maintain a certain consistency, and to sometimes let rules they have learned by experience prevail. A decade ago, many journals routinely deleted "end-of-proof" signs; happily, this battle has been won by the authors who wish to use them. On the other hand, when I submitted my first paper to the AMS Transactions, and had to decide on a way to distinguish, in the introductory section, between certain results and definitions that would be needed in what followed, and other paragraphs of background material that would not be needed but which helped put the needed material in a more meaningful context, I came up with the silly idea of having the latter set in smaller type. The editorial staff gently informed me that this would not be possible, and after my initial annoyance, I agreed to put these paragraphs in square brackets instead; a change for which I remain grateful.

George M. Bergman
University of California, Berkeley
(Received June 13, 1988)
1988 ANNUAL AMS-MAA SURVEY
(First Report)

Salary Survey for New Doctorates
Faculty Survey: Salaries, Tenure, Women

HIGHLIGHTS
1. 856 doctorates in the mathematical sciences were awarded in the period July 1, 1987, through June 30, 1988, by U.S. and Canadian institutions - 703 (82%) were awarded to men. The total number of degrees is an increase of 7% over the average of the fall counts for the last five years.
2. 804 doctorates in the mathematical sciences were awarded by U.S. institutions, an increase over the 779 awarded in 1986-1987, but several hundred below the annual numbers awarded in the early 1970s.
3. Only 45% (363) of the doctorates awarded by U.S. institutions went to U.S. citizens. This percentage has steadily declined since the late 1970s, when three quarters of the doctorates awarded by U.S. institutions went to U.S. citizens. For the second consecutive year the number of doctorates awarded to U.S. citizens is well below 400. The sum total of U.S. citizen new doctorates for the last two years (725) is less than the total for the single year 1974-1975 (741).
4. Although women comprise 21% of the U.S. citizens receiving doctorates, only 16% of the new doctorate hires in the U.S. doctorate-granting departments were women.
5. Starting salaries for new doctorates increased by 4.6% over last year for those reporting nine-month teaching (or teaching and research) positions.

This first report on the 1988 Survey includes a report on the 1988 survey of new doctorates, a report on salaries of new doctorates, salary and other data on faculty members in four-year colleges and universities, and a list of names and thesis titles for members of the 1987-1988 Ph.D. class. The report is based on information collected from questionnaires distributed in May to departments in the mathematical sciences in colleges and universities in the United States and Canada, and later to the recipients of doctoral degrees granted by these departments between July 1987 and June 1988, inclusive. A second round of questionnaires was distributed in September, concerned with data on fall enrollments, class size, teaching loads, and faculty mobility. This data will appear in the second report on the 1988 Survey, in a spring 1989 issue of Notices.

For these reports, departments are divided into groups according to the highest degree offered in the mathematical sciences. The groups are described in the Appendix to this report. See April 1988 Notices, pages 532-533, for a list of Group I and II departments.

The 1988 Annual AMS-MAA Survey represents the third second in an annual series begun in 1957 by the Society. The 1988 Survey is under the direction of the AMS-MAA Committee on Employment and Educational Policy (CEEP), whose members are Morton Brown, Stefan A. Burr, Edward A. Connors (chair), Phillip C. Curtis, Jr., Don O. Loftsgaarden, David J. Lutzer, and Audrey A. Terras. The questionnaires were devised by CEEP’s Data Subcommittee whose members are Edward A. Connors (chair), Lincoln K. Durst (consultant), John D. Fulton, James F. Hurley, Charlotte Lin, James W. Maxwell (ex officio), Donald E. McClure, and Donald C. Rung. Comments or suggestions regarding this Survey may be directed to the subcommittee.

REPORT ON THE 1988 SURVEY OF NEW DOCTORATES
Edward A. Connors

This report presents a statistical profile of new doctorates in the mathematical sciences awarded by universities in the United States and Canada during the period July 1, 1987, through June 30, 1988. It includes the employment status of recipients of 1987-1988 doctorates in the mathematical sciences (as of August 31, 1988), an analysis of the data by sex, minority group, and citizenship, and reports trends in the number of doctoral degrees for each of Groups I through V (see Appendix for description of groups). Table 0 provides the response rates for the 1988 Survey of New Doctorates.

TABLE 0: Response Rates

<table>
<thead>
<tr>
<th>Group</th>
<th>Response Rate</th>
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<tbody>
<tr>
<td>Group I</td>
<td>39 of 39</td>
</tr>
<tr>
<td>Group II</td>
<td>42 of 43 including 6 with 0 degrees</td>
</tr>
<tr>
<td>Group III</td>
<td>72 of 81 including 24 with 0 degrees</td>
</tr>
<tr>
<td>Group IV</td>
<td>50 of 69 including 3 with 0 degrees</td>
</tr>
<tr>
<td>Group Va</td>
<td>10 of 19 including 0 with 0 degrees</td>
</tr>
<tr>
<td>Group Vb</td>
<td>17 of 38 including 3 with 0 degrees</td>
</tr>
<tr>
<td>Group VI</td>
<td>19 of 28 including 5 with 0 degrees</td>
</tr>
</tbody>
</table>
Doctorates Granted

The number of new doctorates reported for 1987-1988 is 856 (fall 1988 count), compared to 845 for 1986-1987 (fall 1987 count). See Table 1A for comparable statistics from 1982-1983 on. These numbers are obtained from the Annual Survey Reports in the November Notices. The number of new doctorates awarded by U.S. institutions in 1987-1988 is 804 (fall count), compared to 779 in 1986-1987 (fall count). As is customary, a second, updated report on the 1987-1988 new doctorates is planned for a spring 1989 issue of Notices.

Table 1A: New Doctorates, Fall Counts

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<tr>
<td>Fall</td>
<td>792</td>
<td>789</td>
<td>769</td>
<td>801</td>
<td>845</td>
<td>856</td>
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</table>

Table 1B contrasts the numbers reported in the fall and spring for the years 1982-1983 through 1987-1988.

Table 1B: New Doctorates, Fall and Spring Counts

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<td>792</td>
<td>789</td>
<td>769</td>
<td>801</td>
<td>845</td>
<td>856</td>
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<tr>
<td>Spring</td>
<td>840</td>
<td>827</td>
<td>807</td>
<td>827</td>
<td>874</td>
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In Table 1C we record the number of new doctorates in the mathematical sciences in the U.S. and Canada from the years 1982-1983, exclusive of Group Vb. The response rate for Group Vb, which includes departments in engineering and management science, is the lowest of all groups.

Table 1C: New Doctorates Awarded by Groups I-Va, VI

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<tr>
<td>856</td>
<td>767</td>
<td>735</td>
<td>755</td>
<td>743</td>
<td>809</td>
<td>787**</td>
</tr>
</tbody>
</table>

** This is a fall count. The other entries in Table 1C are spring counts. Table 1C will be updated to include a spring count for 1987-1988 in a spring 1989 issue of Notices.


Table 2A shows the employment status, by type of employer and field of degree, of the 856 recipients of doctoral degrees conferred by the mathematical sciences departments in the U.S. and Canada between July 1, 1987, and June 30, 1988. The names of these 856 individuals are listed with their thesis titles in a later section of this First Report of the 1988 Annual Survey. Again this year we present the employment status of the 153 women new doctorates in Table 2B.

The employment matrix, Table 2A, is similar to last year's, with a few exceptions. There was an increase in new doctorates hired in Groups I-V (207 compared to 188), and a decrease in new doctorates hired by government and business (96 compared to 110). Although women comprise 18% of the new doctorates (and 21% of the U.S. citizen doctorates), only 16% of the new hires in Groups I-V are women.

In rows 1 through 5 of Table 2A the numbers represent those who have accepted appointments in U.S. doctorate-granting mathematical sciences departments (Groups I-V). In the next two rows the figures represent those accepting appointments in U.S. mathematical sciences departments granting masters and bachelors as the highest degree. The information was initially obtained from the department granting the degrees and from data subsequently supplied by recipients themselves.

Of the 529 new doctorates employed in the U.S. 65% (345) assumed academic positions in university or four-year college mathematical sciences departments, and 21% (112) took employment in government, business, or industry. The former is a five percentage point rise over last year and the latter is unchanged.

Table 2A shows as "not yet employed" about 5% of the 1987-1988 new doctorates, excluding those whose employment status is unknown. The data in Table 2A were obtained in many instances early in the summer of 1988 and do not reflect subsequent hiring; an update of Table 2A is planned for the Second Report in a spring 1989 issue of Notices. A similar update last year revealed that all but 22 new 1986-1987 doctorates found positions by fall 1987 (see Notices, November 1987, page 1082, and April 1988, page 527).

Sex, Minority Group, and Citizenship of New Doctorates, 1987-1988

Table 3 presents a breakdown according to sex, minority group, and citizenship of these 856 new doctorates. The information reported in this table was obtained from departments granting the degrees and in some cases from the recipients themselves.

Of the 804 doctorates awarded by U.S. universities, the citizenship is reported as known for 798 recipients, with 363 reporting U.S. citizenship. Thus, only 45% of the doctorates awarded by U.S. institutions went to U.S. citizens. The percentage of U.S. citizens receiving doctorates in the mathematical sciences has declined consistently, from 73% in 1979-1980 to 45% in 1987-1988. For the second consecutive year the number of U.S. citizens receiving doctorates in mathematics is well below 400. Refer to Table 4 and the accompanying graphs.

Women comprise 21% of the U.S. citizens receiving doctorates in the mathematical sciences from U.S. universities in 1987-1988. Since 1972-1973 this percentage has doubled. It has held fairly constant at or above 20% for the last six years. Table 5 presents the data for the period 1973-1974 through 1987-1988.
in the Mathematical Sciences

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</thead>
<tbody>
<tr>
<td>Group I</td>
<td>11</td>
<td>10</td>
<td>21</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>11</td>
<td>1</td>
<td>6</td>
<td>73</td>
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in the Mathematical Sciences

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TABLE 3: Sex, Minority Group, and Citizenship of New Doctorates
July 1, 1987–June 30, 1988

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Citizenship and Sex of U.S. Doctorates, 1973 to 1988

Again this year, information is presented on the annual number of doctorates granted by U.S. universities to U.S. citizens (Table 4). This number is divided into male and female doctorates (Table 5). These data are presented for the period 1973 to 1988 using the Annual Survey Reports published each year in the November Notices. Thus Tables 4 and 5 are extensions of tables in last year’s Report. In Table 4 the first column (headed Adjusted Total of Doctorates given by U.S. Universities) gives the number of doctorates granted between July 1 and June 30 of the indicated years whose citizenship is known. Column 2 gives the number who are U.S. citizens and column 3 the percentage that this represents. In Table 5 the number in column 2 of Table 4 is further divided into men and women. Note that in both tables all years prior to 1982-1983 include doctorates granted by computer science departments.
Graph for Table 4: U.S. Citizen Doctorates
Total of Doctorates by Percent
The failure of mathematics to match the physical sciences in relative doctoral production:

"The growth evidenced in the 1980s [in the number of doctorates awarded in the physical sciences], however, disguised the fact that the cluster field of mathematics never stemmed the decline that began in the 1970s. The 730 mathematics doctorates earned in 1986 were 43 percent fewer than the 1,281 Ph.D.s earned in 1972. Note that the field of computer sciences was added in 1977, and it attracted some scholars who might otherwise have studied mathematics (or engineering). Yet even when the computer scientists were added to the mathematicians, the combined number in 1986 (1,129) still represented a loss that was double the average size of decline (12 percent, instead of 6 percent). Moreover, the field of mathematics decreased despite its attraction of the largest component of temporary visa-holders of any of the physical sciences - 37.3 percent."


(For a detailed comparison with the physical sciences see Taking Stock: Is American Mathematics in Decline?, Edward A. Connors, The Scientist, to appear.)

### Concluding Remarks

We again express our deep concern at the low number of American citizens receiving doctorates in the mathematical sciences. Tables 4 and 5, and the accompanying graphs, provide cause for alarm within the mathematics community and the many groups it services. American business, industry, government and academe must be prepared for the severe effects of this drought.

We close with a quote from the National Research Council's Summary Report 1986 - Doctorate Recipients from United States Universities, which comments on the failure of mathematics to match the physical sciences in relative doctoral production:

"The growth evidenced in the 1980s [in the number of doctorates awarded in the physical sciences], however, disguised the fact that the cluster field of mathematics never stemmed the decline that began in the 1970s. The 730 mathematics doctorates earned in 1986 were 43 percent fewer than the 1,281 Ph.D.s earned in 1972. Note that the field of computer sciences was added in 1977, and it attracted some scholars who might otherwise have studied mathematics (or engineering). Yet even when the computer scientists were added to the mathematicians, the combined number in 1986 (1,129) still represented a loss that was double the average size of decline (12 percent, instead of 6 percent). Moreover, the field of mathematics decreased despite its attraction of the largest component of temporary visa-holders of any of the physical sciences - 37.3 percent."


(For a detailed comparison with the physical sciences see Taking Stock: Is American Mathematics in Decline?, Edward A. Connors, The Scientist, to appear.)


The figures for 1988 were compiled from questionnaires sent to individuals who received a doctorate in the mathematical sciences during the 1987-1988 academic year from universities in the United States and Canada.

Questionnaires requesting information on salaries and professional experience were distributed to 669 recipients of degrees using addresses provided by the departments which granted the degrees. Of these, 9 were returned by the postal service as undeliverable and could not be forwarded. There were 347 individuals who returned forms between late June and early September. The tables below are based on the responses from 307 of these individuals (240 men and 67 women). Data from 40 responses were not used in the compilation of the tables below; forms with insufficient data, or from individuals who had indicated they had part-time employment, were not yet employed, or were not seeking employment were considered unusable.

Readers should be warned that the data in this report are obtained from a self-selected sample and inferences from them may not be representative of the population. For more comprehensive information on the recipients of new doctorates granted last year in the mathematical sciences in the U.S. and Canada, see the preceding article by E. Connors.

Key to Tables. Salaries are listed in hundreds of dollars. Years listed refer to the academic year ending in the listed year. M and F are Male and Female respectively. One year experience means that the persons had experience limited to one year or less in the same position or a position similar to the one reported; some persons receiving a doctorate had been employed in their present position for several years. (X + Y) means there are X men and Y women in the 1988 sample. Quartile figures are given only in cases where the number of responses is large enough to make them meaningful.

Graphs. The horizontal line represents the median salary for 1987 in hundreds of dollars. The points plotted are the relevant data for each year converted to 1987 dollars using the implicit price deflator prepared annually by the Bureau of Economic Analysis, U.S. Department of Commerce. Where available, first and third quartiles appear as boxes along the vertical lines. (Because the deflator is not yet available for this year, the 1988 figures do not appear on the graphs.)

Note that salaries for teaching, or teaching and research, have yet to return to their high point of 1970, although steady progress has been made since 1980. (For further details, see Donald Rung's article, "A Fifteen Year Retrospective on Academic Salaries of U.S. Doctorate Holding Faculty," in the November 1985 issue of Notices, pp. 772-773.)
### Nine-Month Salaries

#### TEACHING OR TEACHING AND RESEARCH

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#### Nine-Month Salaries

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- 1985F: 200, 232, 250
- 1986F: 240, 240, 240
- 1987F: 240, 240, 240

### Graphs

- **Nine-Month Teaching**
- **Nine-Month Research**

Graph omitted because sample size too small.
### Twelve-Month Salaries

#### TEACHING OR TEACHING AND RESEARCH

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#### Twelve-Month Research

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<td></td>
</tr>
<tr>
<td>1987F</td>
<td>300</td>
<td>424</td>
<td>466</td>
<td>502</td>
<td></td>
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<tr>
<td>1988M</td>
<td>300</td>
<td>431</td>
<td>490</td>
<td>1100</td>
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<tr>
<td>1988F</td>
<td>375</td>
<td>454</td>
<td>495</td>
<td>660</td>
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<tr>
<td>One Year Experience (26 + 4)</td>
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<tr>
<td>1988M</td>
<td>300</td>
<td>415</td>
<td>470</td>
<td>540</td>
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<tr>
<td>1988F</td>
<td>418</td>
<td>426</td>
<td>437</td>
<td>500</td>
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</tbody>
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### Twelve-Month Government

![Bar chart for Twelve-Month Government](image)

### Twelve-Month Industry

![Bar chart for Twelve-Month Industry](image)
Faculty Salaries, Tenure, Women

The questionnaires sent to departments in the mathematical sciences asked for information on salaries and tenure. Departments submitted a minimum, median, and maximum salary figure for each of four academic ranks, for staff members both with and without doctorates. Annual salaries of full-time faculty members for the academic year of 9 or 10 months were sought. The 1988 questionnaire requested information for both the years 1987-1988 and 1988-1989. In the salary tables on the following pages the numbers in parentheses give the range of the middle fifty percent of salaries reported. The figures outside the parentheses represent the minimum and maximum salary listed by any reporting institution. In some categories relatively few departments reported and, because significant figures were not available, salaries are not listed.

The information reported this year on the number of faculty members is based on returns from 729 departments in the mathematical sciences, 60 of which did not contain usable salary information.

<table>
<thead>
<tr>
<th>TABLE 1: Total Faculty Reported for Four-Year Colleges and Universities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total With Total With Total With Total With</td>
</tr>
<tr>
<td>Faculty Tenure Women Faculty Tenure Women Faculty Tenure Women</td>
</tr>
<tr>
<td>WITHOUT DOCTORATE</td>
</tr>
<tr>
<td>Instructor/Lecturer</td>
</tr>
<tr>
<td>Assistant Professor</td>
</tr>
<tr>
<td>Associate Professor</td>
</tr>
<tr>
<td>Professor</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>WITH DOCTORATE</td>
</tr>
<tr>
<td>Instructor/Lecturer</td>
</tr>
<tr>
<td>Assistant Professor</td>
</tr>
<tr>
<td>Associate Professor</td>
</tr>
<tr>
<td>Professor</td>
</tr>
<tr>
<td>Total</td>
</tr>
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<table>
<thead>
<tr>
<th>TABLE 2: Percent of Doctorate Faculty with Tenure</th>
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<tbody>
<tr>
<td>Fall 1987</td>
</tr>
<tr>
<td>Groups I, II, III</td>
</tr>
<tr>
<td>Groups IV, V</td>
</tr>
<tr>
<td>Group VI</td>
</tr>
<tr>
<td>Masters and Bachelors</td>
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<table>
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<tr>
<th>TABLE 3: Response Rates</th>
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<tbody>
<tr>
<td>U.S. Departments</td>
</tr>
<tr>
<td>% Response Group I</td>
</tr>
<tr>
<td>Group II</td>
</tr>
<tr>
<td>Group III</td>
</tr>
<tr>
<td>Group IV</td>
</tr>
<tr>
<td>Group V</td>
</tr>
<tr>
<td>Group VI</td>
</tr>
<tr>
<td>Canadian Departments</td>
</tr>
<tr>
<td>% Response Group VI</td>
</tr>
</tbody>
</table>

Response Rates. Response rates among the various classes of departments vary widely, thus making it difficult to draw firm conclusions about the sizes of the faculty groups studied. Because the questionnaires request data for two years in a row, however, it is possible to estimate relative changes from one year to the next with somewhat more confidence. This year's response rates are given in Table 3. As in past years, the greatest rates of response are in Groups I, II, and III, which have a combined response rate of 80%.
### SIZE OF FACULTY

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>FACULTY</strong></td>
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</tr>
<tr>
<td>Total Tenure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructor/Lecturer</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Professor</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td><strong>Women</strong></td>
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</tr>
<tr>
<td>Total Tenure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructor/Lecturer</td>
<td>88</td>
<td>2</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>161</td>
<td>2</td>
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<tr>
<td>Associate Professor</td>
<td>186</td>
<td>17</td>
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<tr>
<td>Professor</td>
<td>754</td>
<td>753</td>
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</table>

### SALARIES

(in hundreds of dollars)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>DOCTORATE GRANTING DEPARTMENTS</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Group I</strong></td>
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<tr>
<td>WITH OUTDOCTORATE</td>
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</tr>
<tr>
<td>Instructor/Lecturer</td>
<td>76</td>
<td>4</td>
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<tr>
<td>Assistant Professor</td>
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<td>7</td>
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<tr>
<td>Associate Professor</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Professor</td>
<td>95</td>
<td>22</td>
</tr>
<tr>
<td><strong>WITH DOCTORATE</strong></td>
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</tr>
<tr>
<td>Instructor/Lecturer</td>
<td>31</td>
<td>2</td>
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<tr>
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<td>32</td>
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<tr>
<td>Associate Professor</td>
<td>400</td>
<td>380</td>
</tr>
<tr>
<td>Professor</td>
<td>1402</td>
<td>1129</td>
</tr>
<tr>
<td><strong>Group II</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH OUTDOCTORATE</td>
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</tr>
<tr>
<td>Instructor/Lecturer</td>
<td>109</td>
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<tr>
<td>Assistant Professor</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>21</td>
<td>21</td>
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<tr>
<td>Professor</td>
<td>171</td>
<td>57</td>
</tr>
<tr>
<td><strong>WITH DOCTORATE</strong></td>
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<td></td>
</tr>
<tr>
<td>Instructor/Lecturer</td>
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<td>1</td>
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<tr>
<td>Assistant Professor</td>
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<td>414</td>
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<tr>
<td>Associate Professor</td>
<td>667</td>
<td>661</td>
</tr>
<tr>
<td>Professor</td>
<td>1509</td>
<td>1104</td>
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<tr>
<td><strong>Group III</strong></td>
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<tr>
<td>WITH OUTDOCTORATE</td>
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<td></td>
</tr>
<tr>
<td>Instructor/Lecturer</td>
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<tr>
<td>Assistant Professor</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Associate Professor</td>
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<td>7</td>
</tr>
<tr>
<td>Professor</td>
<td>26</td>
<td>12</td>
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<tr>
<td><strong>WITH DOCTORATE</strong></td>
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</tr>
<tr>
<td>Instructor/Lecturer</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Assistant Professor</td>
<td>150</td>
<td>117</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>363</td>
<td>350</td>
</tr>
<tr>
<td>Professor</td>
<td>652</td>
<td>471</td>
</tr>
</tbody>
</table>

| **DOCTORATE GRANTING DEPARTMENTS** |           |           |
| **Group IV**      |           |           |
| WITH OUTDOCTORATE |           |           |
| Instructor/Lecturer | 10 | 0 |
| Assistant Professor | 6 | 4 |
| Associate Professor | 7 | 7 |
| Professor        | 26 | 12 |
| **WITH DOCTORATE** |           |           |
| Instructor/Lecturer | 13 | 2 |
| Assistant Professor | 150 | 117 |
| Associate Professor | 363 | 350 |
| Professor        | 652 | 471 |
### SIZE OF FACULTY

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>WITH TENURE</strong></td>
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</tr>
<tr>
<td>Doctorate</td>
<td>127</td>
<td>106</td>
</tr>
<tr>
<td>Without Doctorate</td>
<td>106</td>
<td>109</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>233</td>
<td>215</td>
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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>WITHOUT TENURE</strong></td>
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<tr>
<td>Doctorate</td>
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<td>105</td>
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<tr>
<td>Without Doctorate</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>225</td>
<td>210</td>
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### SALARIES

(In hundreds of dollars)

<table>
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<tbody>
<tr>
<td><strong>MINIMUM</strong></td>
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<tr>
<td>Doctorate</td>
<td>124</td>
<td>105</td>
</tr>
<tr>
<td>Without Doctorate</td>
<td>105</td>
<td>105</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>229</td>
<td>210</td>
</tr>
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</table>

<table>
<thead>
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<tbody>
<tr>
<td><strong>MEDIAN</strong></td>
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<tr>
<td>Doctorate</td>
<td>181</td>
<td>160</td>
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<tr>
<td>Without Doctorate</td>
<td>160</td>
<td>160</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td>320</td>
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<table>
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<tbody>
<tr>
<td><strong>MAXIMUM</strong></td>
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<tr>
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<td>253</td>
<td>232</td>
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<tr>
<td>Without Doctorate</td>
<td>232</td>
<td>232</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
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<td>464</td>
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</table>
ACKNOWLEDGEMENT

The Annual AMS-MAA Survey attempts to provide an accurate appraisal and analysis of various aspects of the mathematical scene vital to the entire mathematical community. Yearly, collegiate departments in the United States, and the doctoral-granting departments in Canada, are provided the opportunity to respond to this survey. The quantity and quality of the responses directly determine the quality of the information in these reports. Without the dedicated cooperation of the secretarial and administrative support staff in the mathematical science departments we would not be able to conduct a survey, nor be confident in our analysis of its results. We are, unfortunately, unable to thank all the departmental assistants for their cooperation, but it is nonetheless appreciated. However, we are able to thank the administrative support staff of the AMS, especially Marcia Almeida, Monica Foulkes, James W. Maxwell, and James A. Voytuk. Their efforts are acknowledged and appreciated.

| Groups I and II | include the leading departments of mathematics in the U.S. according to the 1982 assessment of Research-Doctorate Programs conducted by the Conference Board of Associated Research Councils in which departments were rated according to the quality of their graduate faculty.¹
| Group I | is composed of 39 departments with scores in the 3.0−5.0 range.
| Group II | is composed of 43 departments with scores in the 2.0−2.9 range.
| Group III | contains the remaining U.S. departments reporting a doctoral program.
| Group IV | contains U.S. departments (or programs) of statistics, biostatistics and biometrics reporting a doctoral program.
| Group V | contains U.S. departments (or programs) in applied mathematics/applied science, operations research and management science which report a doctoral program.
| Group Va | is applied mathematics/applied science; Group Vb is operations research and management science.
| Group VI | contains doctorate-granting departments (or programs) in the mathematical sciences in Canadian universities.
| Group M | contains U.S. departments granting a master’s degree as the highest graduate degree.
| Group B | contains U.S. departments granting a baccalaureate degree only.

¹These findings were published in An Assessment of Research-Doctorate Programs in the United States: Mathematical and Physical Sciences, edited by Lyle V. Jones, Gardner Lindsley, and Porter E. Coggeshall, National Academy Press, Washington, D.C., 1982. The information on mathematics, statistics and computer science was presented in digest form in the April 1983 issue of Notices, pages 257−267, and an analysis of the above classifications was given in the June 1983 Notices, pages 392−393. For a listing of departments in Groups I and II see April 1988 Notices, pages 532–533.

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1. (1;0,0,0,0,1,0,0)

**MATHEMATICS**

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**Stanford University**

13. (0,0,0,4,2,0,7)

**ENGINEERING-ECONOMIC SYSTEMS**

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DuBose, Derrick, The equivalence of determinacy and sharps.
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Ibrahim, Ibrahim, *On large sample observations and estimation of the population variance*.

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Slotnick, Henry, *Multivariate analysis of laboratory test results*.

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Magyar, Peter, *Characteristic group and essential convergence of infinite series of independent random variables*.

Przebinda, Tomasz, *The oscillator duality correspondence for the pair $O(2,2)$, $Sp(2, R)$*.

Sauter, John Kurt, Jr., *Isomorphisms among monodromy groups and applications to lattices*.

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Danaher, Peter, *Estimating the audience for a magazine advertising campaign*.

Rueda, Norma Graciela, *Generalized convexity in nonlinear programming*.

Santana, Paulo, *Finite horizon singular control and a related two-person game*.

Utikal, Klaus, *Inference for a nonlinear semimartingale regression model*.

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Sepil, Canan Ayse, *Dual simplex algorithms for network flow problems and extensions*.

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Davis, Steven Louis, *Single valued and set valued integrals in locally convex spaces*.

Lindsey, Charles, *Two-parameter stochastic processes with finite variations*.

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Peters, Dawn, *Rank test for the one-two sample by variate location problems*.

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Miyamoto, Tadatoshi, Some results in forcing.

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Epperson, Jay, The hypercontractive approach to exactly bounding an operator with complex Gaussian kernel.
Freire, Alexandre, Positive harmonic functions on Hadamard manifolds.
Gregg, Joseph Nealy, The thermodynamic limit and the existence of atoms in Coulomb-like systems.
Hurd, Lyman Porter, The application of formal language theory to the dynamical behavior of cellular automata.

MONTANA

Montana State University

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MATHEMATICAL SCIENCES

Jonca, Katarzyna Kuglarz, Numerical solution of a nonlinear Fredholm integral equation of the first kind.

University of Montana

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MATHEMATICAL SCIENCES


NEBRASKA

University of Nebraska

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MATHEMATICS AND STATISTICS

Coomes, Brian Arthur, Polynomial flows, symmetry groups and conditions sufficient for injectivity of maps.

NEW HAMPSHIRE

Dartmouth College

(1;1,0,0,0,0,0,0)

MATHEMATICS AND COMPUTER SCIENCE

Miyamoto, Tadatoshi, Some results in forcing.

NEW JERSEY

Princeton University

(14;12,0,0,0,0,1,1)

MATHEMATICS

Bluh, Antonia Wilson, Near holomorphy of a certain infinite series at negative integers.
Choi, Suhyoung, Real projective surfaces.
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Gregg, Joseph Nealy, The thermodynamic limit and the existence of atoms in Coulomb-like systems.
Hurd, Lyman Porter, The application of formal language theory to the dynamical behavior of cellular automata.

Im, John J. H., On special values of certain Dirichlet series associated with two Hilbert modular forms.
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Shurman, Jerry, Fourier coefficients of a nonholomorphic Eisenstein series associated to an orthogonal group.
Taylor, Richard, On congruences between modular forms.
Wang, Wen-Xiang, On the compactification of locally symmetric Hermitian manifolds with finite volume.
Yau, Horng-Tzer, Stability of Coulomb systems.
Yuen, David, Second order theta functions and vector bundles on Jacobi varieties.

Rutgers University, New Brunswick

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MATHEMATICS

Berhanu, Shiferaw, Hypo-analytic pseudodifferential operators.
Lafferriere, Beatriz, New fixed point theorems for F-compact maps on cones and some applications.
Mosender-Frajria, Peirluigi, A construction of singular unitary representation of real reductive groups.
Olla, Stefano, Large deviation problems in statistical mechanics.
Schwarz, Willi, Applications of loop groups and standard modules to Jacobians and theta functions of isospectral curves.

OPERATIONS RESEARCH

Crama, Yves, Recognition and solution of structured discrete optimization problems.

Stevens Institute of Technology

(1;0,0,0,0,1,0,0)

MATHEMATICS

DiMarco, David, Realizability of p-point, q-line graphs with prescribed minimum degree, line connectivity and point connectivity.

NEW MEXICO

New Mexico State University

(3;1,0,1,1,0,0,0)

MATHEMATICAL SCIENCES

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Manshad, Shakir Jaber, *The mathematical modelling for optical flow.*


**University of New Mexico**

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**Mathematics and Statistics**


Espino, Victor, *Vortex motion.*


Stidley, Christine Aileen, *The analysis of mixed and random effect models for nonorthogonal designs.*

**NEW YORK**

**Adelphi University**

(3;0,1,0,2,0,0)

**Mathematics and Computer Science**

Pirich, Donna Marie Bridget, *Detection of a low-level, possibly time-delayed signal in unknown ambient background.*

**CUNY, Graduate Center**

(3;0,1,0,0,1,0,0)

**Mathematics**

Boccio, Donna Marie Bridget, *Detection of a low-level, possibly time-delayed signal in unknown ambient background.*

Svitak, Sylvia, *The mathematical foundations of factor analysis through a study of the primary literature.*

Wayne, David, *A system of non-strictly hyperbolic partial differential equations exhibiting a parabolic degeneracy within an infinite strip.*

**Cornell University**

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**Applied Mathematics**

Andreasen, Viggo A., *Dynamical models for epidemics in age-structured populations—analysis and simplification.*

Chu, Clare Yung-Wei, *The fast Fourier transform on hypercube parallel computers.*


Liu, Wei-min, *Dynamics of epidemiological models—recurrent outbreaks in autonomous systems.*

Qiao, Sanzheng, *Fast Toeplitz orthogonalizations.*

Wittner, Ben Scott, *On the bifurcation loci of rational maps of degree two.*

**Statistics**


Ferreira, Irene, *Cluster for the voter model in a random environment and the probability of survival for the biased voter model in a random environment.*

Roy, Rahul, *The Russo-Seymour-Welsh theorem and the equality of critical densities for continuum percolation on \( \mathbb{R}^2 \).*

**New York University, Courant Institute**

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**Mathematics**

Akbik, Safwan, *Large prime divisors and irreducible polynomials over number fields.*

Altmann, Michael, *Controlled branching process models of linearly structured populations.*

Cruz, Ricardo Nogueira da, *Periodic knots.*
Hamaguchi, Satoshi, Anomalous transport arising from nonlinear resistive pressure-driven modes in a plasma.

Jones, James, An asymptotic analysis of an expanding detonation.

Mascagni, Michael Vincent Albert, Negative feedback in neural networks.

Oba, Roger, Doubly infinite Toda lattice with antisymmetric asymptotics.

Schlick, Tamar, Modeling and minimization techniques for predicting 3D structures of large biological molecules.

Shlapentokh, Alexandra, Extension of Hilbert's tenth problem and related results.

Soria, Jose, A study of correlation inequalities for two-component hypercubic q^4 models.

Surace, Steven, Jr., The Schrödinger equation with a quasi periodic potential.

Tepedino Aranguren, Gaetano, Soria, Von Dreifus, Henrique, Normolle, Daniel Paul, Comparison of classification methods for multivariate data.

Spier, Norman A., Some large sample linear and general regression results under variable censoring.

**SUNY at Buffalo**

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**MATHEMATICS**

Meng, Xiao-Qing, Categories of convex sets and of metric space, with applications to stochastic programming and related areas.

Wang, Shin-Hwa, On positive solutions of some nonlinear boundary value problems.

**Statistics**

Park, Eyuhoon, Probabilistic and statistical properties for the class of natural exponential families with power variance functions.

**SUNY at Stony Brook**

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Lee, Eui Yong, A diffusion model for a system subject to continuous mean.

Lee, Seung-Min, Continuous structure functions: Finite minimal vector set, weak convergence and reliability importance.

Wu, Chung-Chung, Contribution to nonparametric curve fitting.

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Basmajian, Ara, Hyperbolic invariants for infinitely generated Fuchsian groups.

Loo, Bonaventure, Branched superminimal surfaces in S^4.

Neymotin, Irina, Zeta-function of subelliptic differential operators.

Vannini, Walter, On the global influence of conjugate points.

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**Syracuse University**

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**MATHEMATICS**

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**University of Rochester**

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**MATHEMATICS**

Huang, Min-Jei, Dynamics for time-dependent quantum mechanical Hamiltonians.

Liu, Li, Processes before extinction and comparison of measures by counting atoms.

Maier, Marie Anna, H-spaces of finite dimension.

Wang, Hann-Tzong, L_p estimates for the restricted X-ray transform.

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**NORTH CAROLINA**

**Duke University**

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**MATHEMATICS**

Kimbell, Julia Howell, On the mathematics, especially differential geometry, of sheet metal forming.

Kontostathis, Kyriakos, On the construction of degrees of unsolvability.

Sylvester, Donna Gates, Large time existence of small viscous surface waves in a three-dimensional ocean without surface tension.

**North Carolina State University, Raleigh**

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**MATHEMATICS**


Munoz-Morales, Eduardo Manuel, Bifurcation analysis of a coevolutionary model with interspecific competition.

Northrup, James Irvin, Pointwise quasi-Newton methods and integral equations.

Osley, Mark Edwin, Moving boundaries in reaction-diffusion systems with absorption.

Pan, Ching-Tsuan, Hyperbolic rotations for downdating the Cholesky factorization with applications to signal processing.
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Moustafa, Magdi Sami, Optimal scheduling in networks of queues.
Muhammad, Abdelfatah A., Information theory and queueing theory via generalized geometric programming.
Onural, Raif Orcu, Closed queueing networks with finite buffers.
Seyedghasemipour, Seyed Javad, Petroleum resource assessment in a partially explored region with a sequential land release scheme.

STATISTICS
Chen, Chao Lung, Estimation problems in group testing.
Chu, Ping-Chu, Modeling water balance in larval Mexican bean beetles, Epilachna variestis Mulsant.
Dassel, Karen Ann, Experimental design for the Weibull function as a dose response model.
Eastwood, Brian James, Confidence interval construction in non-parametric regression estimation.
Eggett, Dennis Lee, A comparative evaluation of some statistics for determining the limits of applicability of a linear regression model.
Holland, David Marshall, Evaluation of a bounded frequency distribution generated by a transformed logistic variable.
Jiang, Changjian, Estimation of F-statistics in subdivided genetic populations.
Lim, June Taeg, A dynamic growth model of vegetative soybean plants under variations of root temperature and nitrogen concentration in nutrient solution.

University of North Carolina, Chapel Hill
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BIOSTATISTICS
Abulata, Mohamed Futuh, Stochastic models of birth intervals according to data ascertainment method and relevant fertility indices.
Howard, George, An evaluation of general linear models to log-rank scores for the analysis of failure time data: With applications to survival following stroke, in the North Carolina comprehensive stroke program.
Jerdack, George, Rank order tests for interchangeability in some restricted and incomplete models.

Marques, Eliana, Analysis of categorical data from longitudinal studies of subjects with possibly clustered structures.
McCarroll, Kathleen A., An evaluation of some approximate F statistics and their small sample distributions for the mixed model with linear covariance structure.
Pantula, Janella Faye, Optimal prediction in linear regression analysis.

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Bass, Robert James, Local range properties and univalence in the Cauchy-Stieltjes space.
Grissom, Charles, Local equivalence of four-state systems with two controls under feedback.
Hoke, Harry Franklin, III, Lie groups which are closed at infinity.

STATISTICS
Kettl, Ernestine Elizabeth, Some applications on the transform-both-sides regression model.
Marques, Mauro, A study of Lebesgue decomposition of measures induced by stable processes.
Palmer, Christopher Ralph, A clinical trials model for determining the best of three treatments having Bernoulli responses.
Tsai, Ming-Tan, Asymptotic optimality and distribution theory of nonparametric tests for restricted alternatives.
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Yin, Yin, Edgeworth expansion in tests concerning heteroscedasticity.

Ohio State University
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MATHEMATICS
Bannai, Etsuko, Positive definite unimodular lattices with trivial automorphism groups.
Ghanaat, Patrick, A deformation technique for almost integrable parallelizations.
Han, Sang, The character tables of certain association schemes.
Kim, Jae Moon, On cyclotomic units.
Ray, Phillip Paul, Classical Kac-Moody algebras in characteristics.
Reeder, Mark Stephen, The Steinberg module and the top cohomology of arithmetic groups.

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Hossain, Ayub, The stochastic preference relations for vector valued attributes.
Jeng, Tian-Tzer, Some contributions to asymptotic theory on hypothesis testing when the model is misspecified.
Lee, Gerald Kichun, The statistical models and analysis of stem cell assay.
Pan, Un-Quei Winkey, Burn-in with mixed populations.
Ting, Chao-Ping, Optimal designs for treatment control comparison.
Yeo, Sungchil, On estimation for a combined Markov and semi-Markov model with censoring.

Ohio University
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Pennsylvania State University

Carnegie-Mellon University
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Brandon, Deborah, On a class of models for heat flow in materials with memory.
Chiu, Chichia, A higher order vortex method for two- and three-dimensional spaces.
Choi, U Jin, Fractional order Volterra equations in Hilbert spaces.

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Galway, Lionel A., Statistical analysis of star-shaped sets.
Thibadeau, Yves, Approximating the moments of a multimodal posterior distribution with the method of Laplace.

Lehigh University
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Kwon, O-Hun, Nonlinear alternative theorems and homogeneous convex-concave programming.
Switkay, Hal Mitchell, Descriptive set theory and large cardinals.

Pennsylvania State University
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Davenport, Daniel Mark, Varieties of power commutative semigroups and their rational languages.
Hirst, Jeffry L., Combinators in subsystems of Z_2.
Loi, Phan-Hung, On the theory of index and type III factors.
Park, Sung Ho, Lipschitz continuous metric projections and selections.
Sheiban, Faraj, Categories and semigroupoids.
Steven, Scott, Group-action graphs and Ramsey graph theory: Investigating the Ramsey numbers R(K_{1,n}K_{k,m}) and R(K_{1,n}B_{k,m}).
Syed, Khalid, M-static modules.
Wang, Hankun, Study of stabilization and energy dissipation for second order vibrating systems.
Yu, Xiaokang, Matrix theory in second-order arithmetic.

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Lele, Subash, A study of estimation procedures for spatial processes.
Linder, Ernst, Statistical inference in the linear errors-in-variables model using the bootstrap with applications in environmental risk analysis.
Suman, Kenneth, A James-Stein type estimator of a distribution function.

Temple University
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Khosh, Siddhartha, Extreme value theory: A non-standard approach.
Shoham, Dan, Pursuit problems.

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Khan, Nazeer, Maximum likelihood ratio classification criterion for mixed binary and continuous variables.
Soper, Keith, General functional models, with application to cytogenetics.

University of Pennsylvania
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Bac, Sunghan, On the conjectures of Lichtenbaum and of Chinburg over function fields.
Kang, Pyung-Lyun, On the variety of plane curves of degree d with σ nodes and κ cusps.
Kim, Seyong, A generalization of Frohlich’s theorem to wildly ramified quaternion extensions of Q.
Pedersen, Sharon Louise, Optimal vector fields on spheres.
Schmutz, Eric J., Statistical group-theory.
Yim, Jin-Whan, Space of souls in a complete open manifold of nonnegative curvature.

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Hwang, Irving, Group sequential significance test for clinical trials.
Weintraub, Keith S., Sample and ergodic properties of some min-stable processes.
Witt, Gary, The analysis of repeated measurements with first-order autocorrelation.

University of Pittsburgh
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Paik, Myunghee, Repeated measurement analysis for the non-normal outcome and its small sample properties.
Zee, Benny Chung Ying, Reliability of total skin score and subgroup classification of progressive systemic sclerosis.

**MATHEMATICS AND STATISTICS**

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Bhandary, Madhu Sudan, Inference on signal processing in the presence of outliers.
Ding, Yijun, Feature selection on covariance matrices and mean vectors.
Mesina, George L., Iterative solutions to Navier-Stokes difference equations.
Zhang, Lu, Selection of features in pattern recognition using information theoretical criterion.

**RHODE ISLAND**

Brown University
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**APPLIED MATHEMATICS**

Fitzpatrick, Ben George, Statistical models in parameter identification and model selection.
Ji, Dunmu, Asymptotic analysis of nonlinear filter problems.
Knoerr, Alan, Global models of natural boundaries—theory and applications.
Mertus, John A., Self calibrating methods for image reconstruction in emission computer tomography.
Pratt, Michael Meade, Analysis of near characteristic methods in the study of steady supersonic flow.
Ramachandran, Kandethody M., Nearly optimal singular controls for wideband noise driven systems and queueing processes.
Rodriguez, John David, Studies of the Ginzburg-Landau equation.
Rothman, Ernest, Preconditioning matrices for spectral derivative operators.
Sakamoto, Kunimochi, The existence and stability properties of transition layers in singularly perturbed ordinary differential equations.
Wang, Chunming, Approximation methods for linear quadratic regulator problems.
Warhola, Gregory Thomas, Steady waves in a nonlinear theory of viscoelasticity.
Zhang, Qing, Controlled partially observed diffusions.

**MATHEMATICS**

Buyske, Steven George, Lie sphere transformations and the focal sets of hypersurfaces.
Curtin, Eugene, Intermediate tautness and relative tautness for submanifolds.
Faucette, William Mark, Harmonic volume, symmetric products, and the Abel-Jacobi map.
Hanamura, Masaki, Motives of perverse sheaves.
Kerckhove, Michael George, Conformal transformations of pseudo-Riemannian Einstein manifolds.
Lopez, Angelo, On the Picard group of projective surfaces.
Solomon, David R., On Lichtenbaum's conjecture in the case of number fields.

**University of Rhode Island**
(4,2,0,0,1,1,0,0)

**MATHEMATICS**

Hamel, Sherry E., Optimization of observability in target tracking with bearings-only measurements.
Hoag, Jeffrey Taber, Existence and uniqueness of solutions for a delayed-advanced model of the two-body problem of electrodynamics.
Partheniadis, Evangelos C., Oscillations and asymptotic behavior of solutions of delay and neutral delay differential equations.
Schultz, Stephen W., Necessary and sufficient conditions for oscillations of neutral differential equations.

**SOUTH CAROLINA**

Clemson University
(4,2,1,1,0,0,0,0)

**MATHEMATICAL SCIENCES**

Eschenbach, Carolyn Pizzulo, Eigenvalue classification in qualitative matrix analysis.
Fox, Kevin L., Some applications of smooth splines to density and cumulative function approximation.
Jones, Wendell Davis, Detecting and understanding joint influence in regression diagnostics.
Shelton, Therese N., The Volterra-Stieltjes integral equation.

**University of South Carolina**
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**MATHEMATICS**

Lin, Chiang, Some topics on partially ordered set.

**ROWE, David Barry, Compact convex subsets in \( L_p(w) \), \( 0 < p < 1 \).**

**STATISTICS**

Berry, Jack Jefferson, Multivariate simultaneous inference.
Lio, Yuhlong, Smooth nonparametric quantile estimation from right censored data.

**TENNESSEE**

University of Tennessee
(2,2,0,0,0,0,0,0)

**MATHEMATICS**

Clark, Stephen, Some qualitative properties of the spectral density function for Hamiltonian systems.
Snyder, David F., Partially acyclic manifold decomposition yielding generalized manifolds.

**Vanderbilt University**
(1,1,0,0,0,0,0,0)

**MATHEMATICS**

Profio, Joseph S., Using sub-normality to show simple connectivity at infinity of a finitely presented group.

**TEXAS**

North Texas State University
(4,3,0,0,1,0,0,0)

**MATHEMATICS**

Brucks, Karen Marie, Dynamics of one-dimensional maps: Symbols, uniqueness, and dimension.
Gragg, Karen, Dually semimodular consistent lattices.
Kurepa, Alexandra, Radially symmetric solutions to a superlinear Dirichlet problem in a ball.
Unsurangsie, Sumalee, Existence of a solution for semilinear wave equation and a nonpositone problem.

**Rice University**
(4,1,0,0,3,0,0,0)

**MATHEMATICAL SCIENCES**

Dawson, Clinton Norman, Error estimates for Godunov-mixed methods for nonlinear parabolic problems.
El-Alem, Mahmoud M., A global convergence theory for a class of trust region algorithms for constrained optimization.
Martinez, Hector Jairo, Superlinear convergence of the structural secant method from the convex class.
Mathematics
Murdoch, Timothy Armstrong, Twisted calibration and cone on the Veronese surface.

Southern Methodist University
(2;0,2,0,0,0,0)

Statistical Science
Cunningham, James Kelly, Robust penalized regression.
Strickert, Donald P., Estimating consumer acceptance limits.

Texas A & M University
(2;0,2,0,0,0,0)

University of Houston
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Mathematics
De Loura, Luis Camillo, Numerical iterative methods for the Hartree equation of helium-like systems.
Gonzalez, Raul Ernesto, A geometric study of certain stochastic semigroups.
Lan, Shaw-Ping, The semigroup of real stochastic matrices and generalized inversion.
Taylor, Monty B., Filtration transforms of integral commutative CL-monoids and lattice modules.
Wray, David Otway, First order quotitional logic.

University of Texas, Arlington
(4;4,0,0,0,0,0,0)

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Hu, Shouchuan, Fixed point theory and differential-integral equations.
Kathirkamanayagan, Mailvaganam, Study of singularly perturbed systems.
Winton, Richard, On subdirectly irreducible groups and automorphism groups.

University of Texas, Austin
(6;3,0,0,3,0,0)

Mathematics
Beneish, Esther, Invertible modules.
Bosse, Marie-Pascale, Homogenization of the layered medium equation.
Koo, Hyeng Keun, Rational function fields and related topics in skew field theory.
Motto, Michael, Surfaces in three-manifolds and three-manifold triads.
Oppenheimer, Seth Frederic, A partial differential equation arising from a problem in the dynamics of gas absorption.
Walkington, Noel John, Resolution of a diffusion problem arising in the flow of fluids.

University of Virginia
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Mathematics
Edmonds, George F., On the thermal stresses due to a uniform heat flow past a circular hole with a radial edge crack.
Hwang, Jen-Ling Grace, On a moving boundary problem of transitional ballistics.
Sabnis, Sanjeev, Large deviation local limit theorems for ratio statistics.

Virginia Commonwealth University
(1;0,1,0,0,0,0)

Biostatistics
Clark, B. Christine, Developmental toxicity data: Trend tests for mean proportional responses from litters of random size.

Virginia Polytechnic Institute and State University
(7;0,7,0,0,0,0)

Statistics
Amin, Raid, Variable sampling interval control charts.
Bauer, Laura Lynn, Hypothesis testing procedures for non-nested regression models.
DeFeo, Patrick A., Sequential robust response surface strategy.

Einsporns, Richard Llyod, A link between least squares regression and nonparametric curve estimation.

Giovannitti-Jensen, Ann, Graphical assessment of the prediction capability of response surface designs.

Marx, Brian D., Ill-conditioned information matrices and the generalized linear model: An asymptotically biased estimation approach.

Senderak, Edith Tan, Design and regression estimation in double sampling.

WASHINGTON

University of Washington

Decker, Naomi, The Fourier analysis of multigrid-type iterative methods.

Goldstein, Steven, Multitype branching processes: Diffusion approximations for critical decomposable processes and calculuations for a cancer tumor growth model.

Lindstrom, Mary Judith, Matching of certain unipotent orbital integrals on p-adic orthogonal groups.

Perkins, Patrick Thomas, Commutative subalgebras of the ring of differential operators on a curve.

Poliquin, Rene Albert, Proto-differentiation and integration of proximal subgradients.

Wolenski, Peter R., Properties of the value function in optimal control.

University of Wisconsin, Madison

(30;23,4,0,0,2,0,1)

MATHEMATICS

Blount, Douglas J., Comparison of a stochastic model of a chemical reaction with diffusion and the deterministic model.

Chen, Chao-Nien, Multiple solutions and bifurcation for a class of nonlinear Sturm-Liouville eigenvalue problems on an unbounded domain.

Costantini, Cristina, The Skorohod oblique reflection problem and a diffusion approximation for a class of transport processes.

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Fares, Jean, The generalized local Lefschetz number.

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Graves, Alan Scott, The splitting of the equivariant J-homomorphism for linear circle actions.

Hall, Mark E., Verma bases of modules for simple Lie algebras.

Harizanov, Valentina, Degree spectrum of a recursive relation on a recursive structure.

Henriques, Pedro, Some variational problems for exterior differential systems.

Hong, Geck Chan, Integral mean estimates for a class of subharmonic functions of finite order in space.

Jiang, Shouli, The strict p-space problem and generalized metric spaces as images of metric spaces.

Lindstrom, Mary Judith, Matching of certain unipotent orbital integrals on p-adic orthogonal groups.

Loveland, Douglas, Stochastic models for the spread of communicable diseases: Parameter estimates and their properties.

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Poliquin, Rene Albert, Proto-differentiation and integration of proximal subgradients.

Wolenski, Peter R., Properties of the value function in optimal control.

University of Wisconsin, Milwaukee

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MATHEMATICAL SCIENCES

Loustau, Philippe, Large subdirect products of modules.

Sridhara, Selvaratnam, Sampling theorems.

University of Wyoming

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MATHEMATICS

Roe, Robert Paul, Inverse limit spaces and dynamics of continuous maps on finite graphs.

University of Wyoming

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MATHEMATICS

Roe, Robert Paul, Inverse limit spaces and dynamics of continuous maps on finite graphs.

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MATHEMATICS

Roe, Robert Paul, Inverse limit spaces and dynamics of continuous maps on finite graphs.
Murdoch, Duncan James, *Models and methods in the risk assessment of chemical carcinogens.*

Remillard, Bruno, *Large deviations and laws of the iterated logarithm for multidimensional diffusion processes with applications to diffusion processes with random coefficients.*

Schmuland, Byron Allan, *Dirichlet forms and infinite dimensional Ornstein-Uhlenbeck processes.*

**Simon Fraser University**

*(2;1,0,0,0,1,0,0)*  
**Mathematics and Statistics**

Wismath, Shelly L., *Hyperidentity and hypervariety results for varieties of semigroups.*


**Université de Montréal**

*(9;7,0,0,2,0,0)*  
**Mathématiques et Statistique**

Ben El Mechaiekh, Hichem, *Quelques principes topologiques en analyse convexe.*

Blanchet, Pierre, *Théorèmes de fusion et du dualité pour les solutions d’équations elliptiques.*

Deguire, Paul, *Théorèmes de coincidences. Théorie de minimax et applications.*


Mghazli, Zoubida, *Une méthode mixte pour les problèmes d’hydrodynamique.*

Piché, Claude, *Ttreillis apparentés aux groupes abelens de torsion.*

Raisi, Nadia, *Analyse proximale en optimisation.*

Rheffouli, Mohammed Reda, *Classes d’opérateurs pseudo-différentiels.*

Zaoui, Mostafa, *Sous-algèbres maximales et automorphismes des algèbres simples complexes.*

**Université Laval**

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**Mathématiques, Statistiques et Actuarial**

Ider, Mostefa, *Calcul symbolique dans les classes de fonctions indéfiniment dérivables et quasi-analyticité généralisée.*

Jamali, Abdelhak, *Sur le théorème du maximum de N. Korevaar pour la fonction de concavité, extension au cas des solutions faibles.*


Tong, Marcel, *Coupures sur les lobdala-algebres.*

Tsai, Chi-Te, *Local Carlemann classes of infinitely differentiable functions and their topological properties.*

**University of Alberta**

*(3;3,0,0,0,0,0,0)*  
**Mathematics**

Forrest, Brian Edmund, *Amenability and ideals in the Fourier algebra of a locally compact group.*

Nazzal, Shakir Hamid, *On the centrality of certain finitely generated soluble groups.*

Yang, Zhoucheng, *Some topological and combinatorial properties of amenable groups and semigroups.*

**University of Saskatchewan**

*(1;1,0,0,0,0,0,0)*  
**Mathematics**

Mashhood, Bahman, *The index in type $H_1$-factors.*

**University of Toronto**

*(13;9,3,1,0,0,0,0)*  
**Mathematics**

Behera, Akrur, *Homotopy theory in groupoid enriched categories.*


Burke, Maxim Robert, *Some applications of set theory to measure theory.*

Churchard, Peter William, *Proper knot theory in open three-manifolds.*

Guinand, Paul Scott, *The structure of quasinilpotent operators.*

Jessup, Barry John, *Rational Lusternik-Schnirelmann category and a conjecture of Ganea.*

Kim, Yang Kon, *Regular germs for p-adic $Sp(4).$*
Statistics
Bagchi, Parthasarathy, Bayesian analysis of directional data.
Ghosh, Sucharita, Some tests of normality using methods based on transforms.
Keen, Kevin John, Estimation of intraclass and interclass correlations.

University of Western Ontario (2;1,0,0,0,1,0,0)

Applied Mathematics
Kocabiyik, Serpil, A study of Oseen flow using integral conditions.

Mathematics
Zelewski, Piotr, Generalization of the Segal conjecture.

University of Windsor (1;0,1,0,0,0,0)

Mathematics and Statistics

Doctoral Degrees Conferred 1986–1987
Supplementary List


California
University of California, Berkeley (2;0,0,0,0,0,2)

Biostatistics
Black, Dennis M., Statistical issues in the analysis of blood pressure data in the presence of treatment.
Lo, Sing Kai, Computer intensive statistical methods for population genetic models.

Minnesota
University of Minnesota, Minneapolis (1;0,1,0,0,0,0)

Statistics
Chaiyakarn, Pintip, Minimizing the expected time to the goal.

Rhode Island
Brown University (1;0,0,0,0,1,0,0)

Applied Mathematics
McGwier, Robert Westmoreland, Regular perturbations and nonlinear filtering.
I approached the Santa Clara Techmart, one of those Silicon Valley black glass monstrosities, with some curiosity. Why would anyone from the University of Illinois choose to introduce a new mathematics program to the world at such a place? Why not at the University of Illinois math department, or, if they wanted to come to the bay area, why not at Berkeley or Stanford?

Five minutes inside the building were enough to answer this naive question. While the invitation to the event described Stephen Wolfram’s *Mathematica* as “the first system to tackle all of mathematics,” this event was not aimed at mathematicians, it was aimed at the press, and most especially the computer press, which can make or break a new entry into the software business. Our own luck at being there was due to our role as editor of this column.

From 11:30 to noon a couple hundred of us wandered around a room with *Mathematica* demos available on the Macintosh and Sun workstations. Copies of the *Mathematica* program, and Wolfram’s book of the same name, hot off the press from Addison Wesley, were handed out, along with cocktails and hors d’oeuvres. Shortly after noon, we were ushered into a room for a talk and short demo by Wolfram himself.

At 28, Wolfram has gone from one of the most promising physicists to appear in years to one of the most unusual software entrepreneurs around. He is anything but modest about his creation. He thinks *Mathematica* is great and he has convinced a lot of important people in the computer business. A four page feature on Wolfram in the April 11, 1988, issue of *Fortune* magazine makes him sound like the Donald Trump of mathematics, with the same passion for “making deals,” and making money. But in person, this short, bearded, slightly rumpled man looks more like a stereotypical mathematician than a Trump. Until he starts talking. Then his fast talking passion

for *Mathematica*, delivered with a trace of an upper class English accent, is unusually infectious.

Wolfram’s demo and speech were followed by a stream of short testimonials. Three or four of these were by people who had actually used the program, but most were by computer industry giants. Indeed, the event gave far less time to demonstrating the mathematical power of the program than to these plugs from bigwigs.

Steve Jobs was there to tell us that *Mathematica* will be packaged with the long awaited NeXT machine. Bill Joy, now a vice president of SUN, told us how pleased SUN was to be one of the first companies to offer *Mathematica*. Larry Tesler, an Apple Computer vp, spoke of Apple’s commitment to the program. Similar testimonials came from spokespersons from IBM, Ardent Computer, and others. This was capped off by a first-class, sitdown lunch.

This was a media event, and it worked. Local television had crews there, and it made the news that night. Wolfram’s picture and an article about the program appeared on the front page of the business section of the *New York Times* the next morning. The program has been discussed in many of the computer industry magazines that flourish in this part of the world. And it has been the subject of many, many messages posted on computer bboards everywhere.

In all of this, there have been a lot of exaggerated claims made about *Mathematica*, not the least of which is that it is able to “tackle all of mathematics.” This sort of hype rubs mathematicians the wrong way. It is not the way we are used to doing things; it feels unseemly. (I have had letters, telephone calls, and email messages from mathematicians worried about the plan to review the program in the column.) But the hype has worked. I would wager that more people have already heard of *Mathematica* than of all the earlier mathematical programs put together. If *Mathematica* is anywhere near as good as Wolfram claims, it is likely to become a standard tool that is available on essentially every computer around.
And, hype or not, that seems to me all to the good for mathematics, for mathematicians, and for everyone who needs to use mathematics. If a standard tool ever emerges from the welter of mathematical software systems around, it will greatly speed progress as people exchange programs written for these systems.

My untutored guess is that Mathematica has a good shot at becoming such a standard. Partly because it is based on sound ideas, both new ideas and ideas present in earlier mathematics systems, but partly because Wolfram has done his homework with the computer industry in a way none of the other developers have managed to do. Any standard has to have versions that work on all the machines we use, from supercomputers to workstations and on to the personal computers we have at home. Wolfram has realized this and has pulled it off. So while as mathematicians we may find the hype distasteful, my bet is that we will also reap its rewards.

A Mathematica User Group, MathGroup, has already been established, with the first chapters in Illinois and the Bay Area. MathGroup plans to operate a bulletin board/archive system that users may call, or get to via a network. Users will be able to upload and download Mathematica notebooks, packages, and other information to and from this computer. They also plan to publish a newsletter and hold a yearly conference. Readers interested in MathGroup should contact:

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National Center for Supercomputing Applications
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Champaign, IL 61820

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The remainder of this month’s column is devoted to a thorough initial review of Mathematica by Eugene Herman, and short comments on the program by a few users with different backgrounds. My own comments on using the program are contained there. It should be noted that the program has only been available for a few months, so the review and commentaries cannot be based on years of experience with the program. I expect we will want to have another review of Mathematica in a year or two, to see how it is coming along.

Mathematica — A Review

Eugene A. Herman
Grinnell College

Introduction

Mathematica’s unique contribution is that it ties together so many disparate mathematical capabilities in such a neat package. It is at once a computer algebra system, a mathematical graphics package, and a collection of numerical routines. But these are not distinct parts of the whole. All the mathematics

Reviewers Still Needed

My pleas for reviewers for mathematical software have brought several responses, but not a lot, and none in some of the fields where I now have software that needs reviewing. In particular, I currently have programs in the areas of stochastic processes and logic and no volunteers yet. If you would be willing to review mathematical software, send me your name, areas of mathematical expertise, and a description of the equipment you have available.

If you have already had experience with some program that you think should be reviewed, write and suggest a review. I will let you know if something is already in the works. It goes without saying that reviewers should not have had any conflict of interest.

Math Unix Query

I have received the following from Garth Gaudry of Flinders University in Australia:

“I would like to obtain a comprehensive listing of mathematical software suitable for either teaching or research, and which would run under UNIX on various SUN computers. I am familiar with MAPLE and have recently seen Mathematica. Does anyone know of applications which have been developed on a MAPLE base?”

If anyone has a comprehensive list of Math Unix software, it would make a nice contribution to this column. Please send it to me at:

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are accessed by a single command language and programming language, and the entire user interaction takes place in a uniform graphical environment called a "notebook."

None of these features is unique. Current versions of computer algebra systems such as MACSYMA, Maple, SMP, MathScribe (an extension of REDUCE), and Derive (a successor to \textmu math) have much in common with Mathematica. They all have added numerical and graphical capabilities, if these were not available originally, and some have developed a more friendly interface. Mathematica, however, has had both the advantage and disadvantage of coming along later and trying to put all the pieces together in a particularly coherent fashion. Occasional comparisons with these systems will help me explain Mathematica's strengths and weaknesses, some of which are inevitably relative. My comparisons, however, are intended solely to illuminate Mathematica, not to serve as capsule reviews of the other packages.

Mathematica was first available on the Macintosh Plus, SE, and II; by now it should be available on other machines. (I used version 1.03, which was the first published version, on two different Mac IIs, one with 2 megabytes of RAM and the other with 4.) It is designed to take advantage of the capabilities of "workstations," as opposed to PCs or terminals. That is, one needs lots of memory and a fast processor to do much work with Mathematica, and the graphical interface requires local memory, bit-mapped graphics, and a windowing system.

In the next several sections, I survey the major features of Mathematica, grouping them under the following headings: graphical interface, mathematical graphics, computer algebra, numerical routines, command and programming languages, documentation, and implementation issues. Then come a number of benchmarks (i.e., worked examples), including some introduced by Simon and Wilson in their review \textit{Supercalculators on the PC} (these Notices, September, 1988, pp. 978-1001).

### Graphical Interface

The metaphor of a notebook aptly characterizes Mathematica's user interface. In any session, all your input goes into the current notebook, and all Mathematica's responses, including the graphs, go in there too. You can start a new notebook or change an old one, and you can print a notebook or execute it. You can even have several notebooks open at once and move information between them. In short, a notebook is a wonderfully flexible kind of object that has attributes of both a document and an interactive command file.

As a document, a notebook can be edited in the familiar point, click, and drag style that Macintosh users will immediately feel comfortable with. You can search, cut, paste, copy, and insert anywhere in the document. You can change fonts and font attributes by choosing, for example, the font of Greek characters, or boldface or italic type, or a larger type font. You can even request that a command be checked for balanced parentheses. A typical use of a notebook as a document would be to print it for a class handout or a preprint of a paper, after you have used the editor to clean it up and add text.

The document might not be as pretty as you would like, however, since mathematical expressions are formatted as they would be on a CRT. You type your input linearly, and the output comes back in a two-dimensional format but divided into screen lines. Here is a typical input/output pair:

\[
\begin{align*}
D[Sqrt[x]/(x+1)\char94 2,x] \\
-2 Sqrt[x] & \quad 1 \\
\hline \\
3 & \quad 2 \\
(1 + x) & \quad 2 Sqrt[x] (1 + x)
\end{align*}
\]

Thus, fractions occupy at least three lines (numerator, horizontal bar, and denominator), exponents are a full line above the base, and no mathematical symbols are available. Both \textsc{Mathcad} (reviewed in Simon's and Wilson's article) and \textsc{MathScribe}, by contrast, have graphical interfaces that produce proper formatting of mathematical expressions, according to their support staff. That is, mathematical symbols such as integral and square root signs are available through special key combinations, brackets and symbols adjust automatically to the changing height of the expressions they encompass, and the vertical spacing of exponents and fractions is improved. The same is reported to be true of Derive, even though its interface is character-based. Mathematica does provide one expression—formatting aid. You can use the \textsc{TeXForm} command to convert individual expressions to \textsc{TeX} code, after which you can send parts of the notebook through your own \textsc{TeX} program.

The formatting of matrices is not completely satisfactory either. You can display a matrix in the usual tabular form, but long rows wrap onto the next line. Furthermore, you cannot edit a matrix in its tabular form. Instead, you must return the matrix to its native form in Mathematica, which is a list of lists.
As a file of commands and programs, a notebook can be executed in a variety of ways. You can execute any individual command by clicking on it and pressing ENTER. Or you can select a group of commands, even the entire notebook of commands, and execute them together. Furthermore, you can execute all the selected commands at once or step through them one at a time. A typical use of a notebook as a command file would be for a classroom demonstration or a reproducible computational experiment to show a colleague.

However, if your notebook contains programs, not just commands, it may execute quite slowly, as programs in Mathematica are interpreted, not compiled. If this happens, you may prefer to write a program in a compiled language. Fortunately, Mathematica provides hooks by which you can execute external programs and transfer data to and from them. (This requires Unix, which my machine does not have.) Mathematica notebooks have a further set of capabilities, the likes of which I have seen nowhere else. Each command you enter, each block of text you type in, and each chunk of Mathematica's computational or graphical output occupies a single notebook “cell.” These cells can be selected, grouped, hidden, deleted, moved, created, and given a variety of special characteristics.Capabilities of this sort remind me most of an outliner, a program you use to create a detailed outline in preparation for writing a long document. In fact, as with the typical Macintosh outliner, you can organize a notebook into sections and chapters, hiding details until the reader asks to see them. This suggests an especially appealing use of a notebook—as a well-organized executable document. A student or colleague could read any part, execute any part, change any part, and perhaps send the modified notebook back to you.

Note: The notebook graphical interface is part of the Macintosh implementation of Mathematica and of implementations on other machines that can support a graphical interface; this might not include your machine.

Mathematical Graphics

Of the substantive parts of Mathematica, its mathematical graphics are the most impressive. In no other package have I seen graphs of functions of one and two variables drawn so well and with so little insight required of the user. Here are two typical examples:

\[
\text{Plot[Sqrt[4-x^2]/x^2/(1-x^2),}
\{x,-3,3}\]

\[
\text{Plot3D[(x-2-y^2)/(x^2+y^2),}
\{x,-1,1\},\{y,-1,1\}\]

In the first example, notice that I thoughtlessly asked for the function to be graphed on the interval \([-3,3]\), even though it is only defined on a subset. Although Mathematica did display some warning messages (not shown here), it had no difficulty determining the domain. It also made a reasonable choice of bounds for the vertical axis with no help from me, and it displayed the graph’s behavior near the asymptotes quite clearly. (The graphs do not look this good on the screen as the resolution there is not as fine.)

In the second example, the graph’s behavior near the singularity again shows up clearly. You can almost
see a vertical line of limit points above and below the origin. Furthermore, the bounding box and the surface shading help you perceive the orientation of the surface in three-space and the relative positions of the surface patches (lighter patches being higher than darker patches).

Thus, the designers have done a good job of avoiding the pitfalls that all function graphing programs stumble into sooner or later—inappropriate default scaling in the vertical direction, too little detail when the dependent variable changes rapidly, choking on undefined values of the function, and leaving you disoriented in space. *Mathematica*'s plotting routines do better, in part, because their adaptive algorithms plot more points where the dependent variable changes rapidly; reasonable bounds on the vertical axis are found by discarding outliers. Furthermore, the speed of graphing is usually good; the above examples took 2.7 seconds and 6.4 seconds, respectively.

If your graph does not look as good as you want, however, the Plot and Plot3D commands have a large number of options, a feature that most *Mathematica* commands share. For example, in Plot you can change the number of sample points to be plotted, specify the range of the dependent variable, and change the aspect ratio. Also, you can add such details as labels, tick marks, and a frame. In Plot3D, you can also change the simulated lighting on the surface and the view point from which you see it.

For functions of two variables, *Mathematica* also has commands for drawing contours and "density." A density plot is much like a family of contours, except that it shades the plane rather than drawing curves in it, and higher points are indicated by lighter shading, which lets you distinguish local maxima, local minima, and saddle points. In fact, I often find that projections of surfaces on a plane are not as helpful in displaying crucial aspects of a function's behavior as a planar graph of contours and critical points. (Unfortunately, the DensityPlot command is not working in version 1.03 of *Mathematica*, although it is said to be fixed in version 1.1 to be distributed in early October.)

There are a number of other graphing commands, but the most intriguing ones are a collection of animation routines that were added at the last minute. You first use a command in one of the external packages to create a family of related graphic objects, such as graphs of functions or contours or densities; then you select a menu item that animates the whole group by displaying them in rapid succession. The animation is so fast that you get the illusion of smooth motion, even for quite complicated objects such as surfaces. For example, you could demonstrate several revealing views of a surface at once by creating an animation that gives one the illusion of flying by the surface. In fact, FlyBy is a command in the external animation package.

I have not yet mentioned how the graphics are generated in *Mathematica*. This too is distinctive: All its graphics are generated from PostScript, a graphical page description language. So when you give a graphics command, first you notice the pause which indicates that PostScript code is being generated; then the picture is drawn almost all at once. One advantage of using PostScript is that most modern printers, especially laser printers, recognize PostScript and generate high quality output from it. Another is that *Mathematica* lets you modify the PostScript code it generates and even write your own code. For example, you might give a command to generate a graph, select the cell containing the graph, choose a menu item to reformat the graph (upon which it changes immediately from picture to PostScript code), edit the code, and again reformat the cell to get your new graph.

There is a disadvantage to this method of generating graphics: It does not lend itself as well to making interactive pictures. In *Mathematica*'s version 1.03, for example, you cannot request the coordinates of an interesting point by clicking on it, and you cannot blow up an interesting region by dragging a rubber band rectangle around it. (The developers now report that these two features will be available in version 1.1!)

All in all, *Mathematica*'s graphics are the best I have seen in a mathematics package and may set a standard for others to follow.

**Computer Algebra**

*Mathematica* has a reasonable set of computer algebra routines but it is a substantially smaller collection than, for example, *MACSYMA* and *Maple*. Its symbolic integrator handles a much smaller set of functions, it has no symbolic ODE solver, and it cannot sum infinite series or finite series of indeterminate size symbolically. *Mathematica* is more on a par with *SMP* in this respect. However, *Mathematica* is still under development and is continuing to acquire capabilities.

Another possible deficiency of *Mathematica*'s computer algebra is the slowness of certain key routines. I qualify this assertion because of the great variation in speed one gets in different applications of the same basic command and because I compared the different packages on different machines. Still, it is surprising
to me that $\int \sin^2 x/(1 + \cos x) dx$ took 10 seconds to evaluate, as did the simplification step in the "Integrate" benchmark. (These benchmarks, each with its own name, are reported on in a later section.) The times are not typical, of course, but they are not rare and much longer times can easily occur.

Yet another aspect of Mathematica's computer algebra that seems deficient is the quality of its simplification routines. The Integrate command, for example, often produces a long and complicated result.

To take an extreme case, the command

\[
\text{Integrate}[x^4 \sqrt{1 - x^2}, x]
\]

produces a sum of 8 large terms, while other computer algebra systems and hand methods produce a much more compact result.

Of course, you could then apply the Simplify command which, though slow, does an excellent job of producing just the simplification you want for many algebraic expressions. But when it does not do the job, the other routines for transforming algebraic expressions are often not powerful enough to help. For example, differentiating the result of the above Integrate command yields a sum of 15 terms, and simplifying reduces that to 14 terms rather than the original single term. Further attempts to simplify by using combinations of commands caused the program to crash or get stuck in an infinite loop, behavior that is all too common in the current version of Mathematica. Comparable commands in Maple and MACSYMA seem to be much more powerful, especially in their ability to simplify expressions involving radicals and trigonometric functions.

There is also a small part of Mathematica's computer algebra system that produces many wrong answers. In my nonrandom tests, improper integrals were evaluated incorrectly more often than correctly. Some clearly convergent integrals evaluated to "indeterminate" or "complex infinity," a few divergent integrals evaluated to a constant, and there were occasional bizarre results such as $\int_0^1 1/x \, dx$ evaluating to $\log[x]$. Also, a few indefinite integrals were evaluated incorrectly. The simplest was $\int 1/(x^3 + x) \, dx$, which evaluated to an antiderivative of $1/(x^3 + 1)$. The support staff for Mathematica report that they have corrected many of these bugs in version 1.1.

I do not mean to be overly negative about the quality of Mathematica's computer algebra. In fact, Mathematica has some very general and powerful constructs that bode well for its future. I have in mind here its notion of transformation rules acting on patterns of expressions, which I discuss later. Expressions in Mathematica have a detailed structure and precise syntax that makes them relatively easy to take apart and transform. Also, the methods for constructing and applying transformation rules to expressions are rich in variety and power. (The "Series Solution" benchmark shows off the power of transformation rules.) The graphical interface helps too in picking apart expressions, as it lets you select a part by pointing and dragging with the mouse. Another strong point of Mathematica's computer algebra system is its rich collection of integer functions, which includes the Euler totient and Möbius functions, the Jacobi symbol, and Bernoulli and Stirling numbers.

Still, it is a fact that a few very powerful computer algebra systems have been around a long time and are now quite robust and reliable packages. They set a standard that is hard to match.

**Numerical Routines**

Mathematica has quite a solid collection of numerical routines. To begin with, it has an impressive collection of built-in analytic functions that can be evaluated to an arbitrary precision for all complex numbers in their domains. Even MACSYMA with its large SHARE directory lacks some of these. A few of the more exotic functions in Mathematica are the Jacobi polynomials, the hypergeometric functions, and some unusual elliptic functions called EllipticLog and EllipticExp.

Then there are commands for numerically evaluating integrals, solving a system of nonlinear equations, fitting data to a linear combination of functions by least squares, applying a discrete Fourier transform to data, and several more for matrix computations. Although the latter are not as extensive as the matrix routines available in MATLAB (see Simon's and Wilson's review), they include commands for computing the singular values of a matrix, the Moore-Penrose inverse of a matrix, and a complete set of eigenvectors and eigenvalues of a general real square matrix.

These numerical commands are quite flexible. In many of them, you can override such default values as the number of digits to be used in internal computations and the number of digits of accuracy sought. They also seem to be fairly sophisticated in that some of the usual badly behaved examples are handled well. For example, the numerical integration routine can handle certain isolated singularities. It correctly evaluated $\int_0^1 1/\sqrt{x} \, dx$ when told to use $x = 0$ as one of its evaluation points; but when attempting to evaluate $\int_0^1 \log(1 - x)/x \, dx$, it complained that $\log(0)$ is not a number.
I wish there were more numerical capabilities, of course. For example, a good routine for numerically solving a system of differential equations with automatic step size control would be most welcome. Also, Mathematica is no substitute for a good subroutine package of numerical routines. You cannot examine the code to check the algorithm, or print out intermediate results to see how the computation is developing, or compare the results of different algorithms. In fact, almost no information is provided about the algorithms used in Mathematica's numerical routines.

The speed of the numeric computations might be an issue in some environments. Most of the numerical routines seemed reasonably fast, although the “Gibbs” benchmark suggests that some numerical summations are slow and the “DE” benchmark suggests that some function evaluations are slow. On a Mac Plus or SE, however, the results could be much less satisfactory. The speed of their 68000 chip is significantly slower than the Mac II's 68020, and they have no floating-point coprocessor. Significantly slower floating-point computation would also lead to significantly slower graphing speed.

Command and Programming Languages

Mathematica's command language is quite similar to those of other computer algebra systems. Maybe someday a clever software designer will figure out how to let us communicate mathematics to a computer in a style closer to the way in which we write mathematics; otherwise we may all have to learn to write mathematics in a style closer to one recognizable to a computer algebra system. (I have not worked with the two-dimensional input schemes in MathScribe and MATHCAD, so I cannot say if they are, in fact, more natural and easier to learn.) Fortunately, once you learn the syntax of Mathematica's command language and train yourself to use the right symbols in the right places, you can rely on its consistency to help you extend your vocabulary of commands. Also, the graphical interface saves you from much of the tedious typing you would have to do at a CRT. If you make an error in a command, you just edit the few incorrect characters with the aid of the mouse and then press the ENTER key to execute the corrected command. Or, if you want to execute the same command several times with variations, you can again do so by editing. You can even reformat an expression in two-dimensional output form to linear input form and then convert it into a command by simple editing. Another nice touch is that when the editor detects an error, it doesn't just beep at you; it moves the cursor next to the error.

Here are some examples, however, of the kinds of details you must master. Every Mathematica symbol begins with a capital letter and contains no other capitals, unless it is a concatenation of two words. (Wisely, symbols are written out as full words such as Integrate, Simplify, and WorkingPrecision, so you do not have to guess at abbreviations.) There are four kinds of brackets, (, [, {, and [[], and none can be used interchangeably with the others. There are at least five kinds of equal signs, although only ==, :=, and === are used often. The following four statements, though similar in appearance, have different meanings:

\[
f[x] = x^2; \quad f[x] := x^2; \quad f[x_] = x^2; \quad f[x_] := x^2
\]

(The underscore indicates a dummy variable; the colon-equal indicates that the computation of the value of \( f \) is to be deferred until it is needed.)

I did not use the programming language enough to give it more than a partial assessment. It certainly ties neatly into the command language. For example, you can define a new command by writing a procedure that defines it. Then you execute it just as you would a built-in command. You can define new functions, either explicitly or recursively. You can save your definitions and hide the details, or you can weave them into your current session. For example, the following two statements define the factorial function recursively:

\[
\begin{align*}
f[1] & = 1 \\
f[n_] & := n \ f[n-1]
\end{align*}
\]

Here \( f[1] \) is computed immediately as having the value 1 (since equal is used), but other values of \( f \) are not computed until needed (since colon-equal is used for them). Furthermore, \( n \) is a dummy variable since it is followed by an underscore (called a “blank”). The programming language also has an extensive collection of loop constructs and conditionals borrowed from other languages. So you are likely to find many you are immediately comfortable with. The external packages that you get with Mathematica are, in fact, notebooks of functions and commands written in this programming language.

The command and programming languages fit together well because they are actually one language, a tree-structured LISP-like language that is rather similar to those built into other computer algebra systems.
systems. *Mathematica*'s language seems particularly well-defined and general. It is based on three fundamental unifying concepts: expressions, transformation rules, and patterns. All objects in *Mathematica* are called expressions and are defined by a precise syntax. All actions in *Mathematica* can be described as transformation rules that change expressions from one form to another. And, finally, transformation rules act not just on individual expressions but on entire classes of expressions, called patterns. For example, in the second line of the above definition of factorial, \( n \) is a pattern standing for any positive integer, and the equation is a transformation acting on this pattern but whose execution is deferred until it is required. However, a pattern can be a class of expressions of any type, not just numeric expressions. So the language is a natural one for a computer algebra system, as it is designed explicitly to act on quite general classes of symbolic expressions by quite general transformation rules.

There are no required data types in the *Mathematica* language, but data types such as Integer, Real, and String are recognized and taken into account. In particular, you can declare a pattern variable to be of a particular data type. For example, in the definition of factorial above, we could restrict \( n \) to be an integer by typing \( n \_ \text{Integer} \) in place of \( n \_ \). Restricting \( n \) further to be a positive integer can be done by adding a side condition to the definition.

### Documentation

*Mathematica* has good documentation, both on-line and printed. From within the program, you can find out all the options that a command permits, the meaning of any menu choice, and the conventions governing notebook cells. However, you cannot ask for the syntax of a command or a worked example on line. Error messages are usually clear and specific, although forgetting to capitalize properly does not yield a sufficiently specific message for the beginning user.

The *Mathematica* book is especially good. In addition to the usual reference guide describing each command, it has a quick tutorial chapter, a survey chapter that goes into somewhat greater depth, and more advanced chapters on the structure of the language, the mathematical commands available, and techniques for writing programs. Furthermore, unlike the usual user manual, the *Mathematica* book is written in readable, standard English and was printed by a professional book publisher adhering to normal standards. Thus, concepts and conventions are explained in full sentences organized into coherent paragraphs and sections. Annotated examples abound and are set off in distinctive fonts. Summaries of conventions are highlighted on a gray background. The paper and binding are of good textbook quality. (I have not seen the paperback version.) And, finally, the index is quite thorough and uses a variety of fonts to convey extra information.

### Implementation Issues

There are technical deficiencies in the current implementation of *Mathematica* that may concern users. First, although *Mathematica* will indeed run on a Macintosh with only 2 megabytes of RAM, I doubt that many users will be willing to put up with the limitations this entails. One limitation is that parts of *Mathematica* cannot be loaded in such a small machine, the key part being the symbolic integrator. Another is that many computations go more slowly when random access memory is scarce, since the program spends more time clearing out unneeded data and code from memory in that case. Yet another is that a *Mathematica* session uses up memory very quickly. After three or four surface plots, for example, you will probably be unable to continue.

Unfortunately, when memory is used up, you must exit the program and start *Mathematica* up again. Deleting your notebook, clearing all variables of their values, and clearing out *Mathematica*'s history of your session do not free much memory. I think most users will want a minimum of 4 megs. Even in that environment, you can use up memory quickly by running a couple of animations.

There is one nice way around the memory limitation. Because the graphical interface is separate from *Mathematica*'s "kernel," you can install them on separate machines. For example, you could run the graphical interface on a 1 meg Macintosh and have it communicate with a kernel residing on a mainframe. Computations would probably be quite fast in such an environment, although timesharing would slow down the transmission of graphical data and other large bursts of output.

A much more serious deficiency is how *Mathematica* reacts when it runs out of random access memory. Sometimes you get an appropriate warning message that gives you the chance to save your notebook before exiting. More often, however, *Mathematica* either gets stuck in an infinite loop or crashes! Although you can abort a long computation via the standard Macintosh Command-Period key combination,
**Mathematica** does not respond to the abort request when stuck in an infinite loop. So in either case, you lose your current session. Moreover, even when I did get a warning message, I was not always allowed to save my notebook.

I recommend saving your notebook frequently or waiting for a later version of Mathematica. According to the support staff, version 1.1 is much improved in this respect.

## Benchmarks

As in the Simon and Wilson review, these benchmarks should not be thought of as impartial scientific tests of the package but as worked examples that illustrate both how one uses the package and what some of its strengths and limitations are. The first four are taken from that review.

**Roots.** Find the roots of \( x^3 - x^2 - x - 1 = 0 \).

The commands

```mathematica
Solve[x^3 - x^2 - x - 1 == 0, x]
NRoots[x^3 - x^2 - x - 1 == 0, x, 10]
```

produced, respectively, the three exact roots (in 0.8 seconds) and numerical approximations accurate to 10 digits (in 0.08 seconds). With 10 replaced by 20, the latter command took 1.7 seconds.

**Hilbert.** What is the largest Hilbert matrix \( H_n \) which can be successfully inverted?

I defined the Hilbert matrix \( H \) in one line and wrote a program `ERR` to calculate the maximum of the absolute values of the union of the entries of \( I - HH^{-1} \) and \( I - H^{-1}H \). These were, respectively,

\[
H[n_] :=
Table[1/(i+j-1), {i,n}, {j,n}];
\]

\[
ERR[n_] :=
Block[{error, h, hinv, eye},
  h = N[H[n]]; 
  hinv = Inverse[h];
  eye = IdentityMatrix[n];
  error = Max[Abs[eye-h.hinv], Abs[eye-hinv.h]]
  Return[error];]
\]

The results were

- \( n = 11 \): 0.00000739098 in 4.7 seconds
- \( n = 12 \): 0.0024128 in 5.9 seconds
- \( n = 13 \): 0.00292969 in 7.1 seconds
- \( n = 14 \): 0.160645 in 9.8 seconds plus a warning about a badly conditioned matrix.

Of course, much greater accuracy can be had simply by increasing the precision in the step \( h = N[H[n]] \), and perfect accuracy obtained if the Hilbert matrix is left in symbolic form.

**System.** Solve the system of equations

\[
\begin{align*}
\sin(x) + y^2 + \log(z) &= 7 \\
3x + 2y - z^3 &= -1 \\
x + y + z &= 5
\end{align*}
\]

First I defined functions \( f, g, h \) for the left sides of the three equations. Then the following command, which makes the initial guess \( x = 0, y = 1, z = 1 \), produced one solution accurate to 13 places:

```mathematica
FindRoot[{f[x,y,z]==7, g[x,y,z]==-1, h[x,y,z]==5}, 
  {x,0}, {y,1}, {z,1}, 
  AccuracyGoal -> 13, 
  WorkingPrecision -> 26]
```

Changing the initial guess for \( y \) from 1 to 0 produced another. The time for each computation of a solution was at most 1.4 seconds.

**Gibbs.** The \( n \)th partial sum of the Fourier series for \( \frac{\text{sgn}(x)}{2} \) is

\[
f_n(x) = \sum_{k=1}^{n} \frac{\sin(2k-1)x}{2k-1}
\]

Study the Gibbs overshoot graphically and analytically, emphasizing \( f_{20} \). In particular, graph \( f_{20} \) on the interval \( [0, \pi/2] \), find its maximum on this interval, and find its average value on \( [1, 2] \) by computing \( \int_{1}^{2} f_{20}(x)dx \). Also compare the graphs of \( f_8, f_9, f_{10} \) on the same set of axes, and evaluate \( f_{500}(x) \) and \( f_{10000}(x) \) for a few values of \( x \).

Plotting a sum of twenty terms was slow. I experimented with several methods, the fastest of which was to create the function symbolically first, then evaluate its coefficients numerically, and finally plot it:

```mathematica
f20[x_] = 
  N[Sum[Sin[(2k-1)x]/(2k-1), {k,20}]]
Plot[f20[x], {x,0,Pi/2}]
```

The plot took 46 seconds. When I used NSum, the numerical summation command, in place of Sum, the plot took more than 6 minutes. (The developers explain that the adaptive plotting algorithm is a main cause of the slowness with which these graphs are drawn. Because the sum of the sine curves is so wiggly, the adaptive algorithm selects more than ten times the default number of plot points.)
The numerical integration command also was slow when applied to a sum. For this problem, it was much faster to integrate symbolically, then evaluate numerically. The first of the following two commands took 100 seconds; the second, 13 seconds:

\[
\text{NIntegrate}[f20[x], \{x, 1, 2\}, \\
\quad \text{AccuracyGoal} \to 10, \\
\quad \text{WorkingPrecision} \to 20] \\
\text{NIntegrate}[f20[x], \{x, 1, 2\}, 10]\]

There is actually a built-in command for finding local minima of functions of several variables by a method of steepest descent. This produced (to 6 places) both the maximum value of \( f_{20} \) and its argument (in 4.6 seconds):

\[
-\text{FindMinimum}\left[-f20[x], \{x, 0, 0, \pi/2\}\right]
\]

The command

\[
\text{Plot}\left[f8[x], f9[x], f10[x]\right], \\
\{x, 0, \pi\}
\]

superimposed the three graphs suitably but showed them all in the same line style and color. Specifying a collection of different line styles is possible but tedious; typical specifications are

\[
\text{Dashing}[0.05, 0.05], \text{GrayLevel}[0.5]
\]

Numerical evaluation of \( f_{300}[1] \) and \( f_{1000}[1] \) took 8.7 seconds and almost 3 minutes, respectively. These times were obtained by summing symbolically, then evaluating numerically. As with \text{NIntegrate} above, summing numerically was much slower. I also wrote a program to compute \( f_{300}[1] \) in a do loop; it took only a little longer than 8.7 seconds.

Prime factors Decompose 266382004787 into its prime factors.

In 23 seconds, the following command produced the two nearly equal prime factors.

\[
\text{FactorInteger}[266382004787]
\]

Plot Graph the following function on too large an interval, such as \([-3, 3]\):

\[
y' = \frac{\sqrt{4 - x^2}}{x^3(1 - x^2)}
\]

I did this example in the section on Mathematical Graphics.

DE Solve both numerically and symbolically the following initial-value problem; also graph the solution.

\[
y' = 1 - 2xy, \quad y(-1) = 0 \quad \text{on} \quad [-1, 2]
\]

There is an external package containing a standard fourth-order Runge-Kutta method. Here is how I called it up and used it. (The number 0.1 is the step size.)

\[
\text{RungeKutta}\left[1-2x \ y, \{x, y\}, \{-1, 0\}, \\
\quad 0.1, 30\right] \\
\text{ListPlot}[\%, \text{PlotJoined} \to \text{True}]
\]

Because I set \text{PlotJoined} to True, the plot was a curve rather than 30 discrete data points.

Since the differential equation is linear, it can be solved symbolically as follows:

\[
f[t_] = \text{Integrate}[\text{Exp}[x^2], \\
\quad \{x, -1, t\}] \\
\text{Plot}[f[x], \{x, -1, 2\}]
\]

The first step took 2.3 seconds and produced the correct result (where \( I = \sqrt{-1} \)):

\[
I - \text{Sqrt}[\pi] \text{Erf}[-I] + 2 - I - \text{Sqrt}[\pi] \text{Erf}[I t] 2
\]

The plot was slow (81 seconds) and incorrect. It turned out that \( \text{Erf}[-I *t] = \text{Erf}[I *t] \) instead of \( -\text{Erf}[I *t] \).

Integrate Evaluate symbolically and check by differentiation:

\[
\int \frac{1 + x}{1 + x^2 + x^4 + x^6} \, dx
\]

The following steps produced the integral symbolically (in 2.7 seconds), differentiated the result (in 0.25 seconds), and rewrote the derivative in essentially the same form as the original function (in 10.3 seconds):

\[
\text{Integrate}[\text{D}[y, \{x, 2\}], \\
\quad \text{Series}\left[\text{Sin}[x], \{x, 0, 6\}\right] y \\
\quad \text{D}[y, x] \\
\quad \text{Simplify}[\%]
\]

Series solution Find the terms through \( x^6 \) of the power series solution of the initial-value problem

\[
y'' + \sin(x)y = 0, \quad y(0) = 0, \quad y'(0) = 1
\]

\text{Mathematica's} transformation rules made this potentially messy problem go particularly smoothly.

\[
y = \text{Series}[f[x], \{x, 0, 6\}] \\
y = y/.\{f[0] \to 0, \ f'[0] \to 1\} \\
\text{Derivative[n_][f][0] \to a[n]} \\
eqn = \text{D}[y, \{x, 2\}] + \\
\text{Series}[\text{Sin}[x], \{x, 0, 6\}] y = 0 \\
\text{var} = \text{Table}[a[k], \{k, 2, 6\}] \\
\text{Solve}[\text{eqn}, \text{var}]
\]

\[y/\%\]
which produced the result

\[
\begin{array}{cccc}
4 & 6 \\
x & x & 7 \\
x - & - & + & - - & + 0[x] \\
12 & 180
\end{array}
\]

The six steps in the computation have the following effects. The first step expresses \( y \) symbolically as the sum of seven terms of the form \( f^{(n)}[0]x^n/n! \) plus a remainder. The next step replaces \( f[0] \) by 0, \( f'[0] \) by 1, and the higher derivatives \( f^{(n)}[0] \) by \( a[n] \). Then the name \( \text{eqn} \) is assigned to the differential equation in series form and the name \( \text{var} \) to the list of five unknowns \( a[2], \ldots, a[6] \). The Solve command breaks up the differential equation into the five equations that result from setting the coefficients of \( x^0, \ldots, x^4 \) equal to zero; then it solves this system for the five unknowns. The final command displays \( y \) with the coefficients \( a[n] \) replaced by the values found by Solve.

**Conclusion**

Despite its many imperfections, Mathematica comes close to my notion of the ideal general-purpose mathematics package. In time, most of the current bugs will be fixed, implementation flaws overcome, and missing capabilities added (assuming, of course, that the development effort continues). However, some of these improvements will be harder than others, and special-purpose programs will always have their advantages.

Mathematica starts with a sound basis from which it can grow and improve. Its notebook interface is a good idea and well implemented; its language seems to be as powerful and as capable of sustaining further growth as those of other computer algebra systems; its numerical routines and especially its mathematical graphics are remarkably robust; and its collection of built-in functions is substantial. Mathematica also has an intangible, and possibly subjective, strong point—its “feel.” It provides so many different kinds of useful mathematical capabilities and packages them in such a convenient and conceptually simple environment, that using Mathematica almost feels like scribbling mathematics on a notepad with welcome enhancements.

Of the many improvements needed in Mathematica, the most urgent concerns its behavior when random access memory runs out. Its tendency, when this occurs, to crash or get stuck in an infinite loop is unfortunate.

Next in importance, by my standards, is improving the formatting of Mathematica’s output, which currently limits the range of uses of the package. I doubt many users would find the physical appearance of a printed copy of a Mathematica notebook to be satisfactory for either a class handout or a preprint of an article, for example. Some may be willing to convert shorter documents to TeX code through repeated use of the TeXForm command. But most users, I suspect, will want built-in integral and summation signs, better formatting of fractions and exponents, and brackets that scale to appropriate heights.

The areas of mathematics in which Mathematica is most seriously deficient are, in my opinion, differential equations and difference equations. Given the current high degree of interest in dynamical systems, additions here would probably be welcomed by many. Also, the computer is a natural tool for studying dynamical phenomena, as Phaser has shown. Phaser is a small PC package that is limited to numerical solution of dynamical systems and graphical display of these solutions, but its graphics are quite varied and effective. Mathematica would benefit from graphical routines for displaying normalized direction fields and flows plus the underlying numerical routine for solving systems of differential equations. Adding symbolic capabilities would be harder, of course. Two I would like to see eventually are an ODE solver and a summation routine for finite and infinite series comparable to those found in Macsyma and Maple.

**Summary of Mathematical Features**

The list below is not complete. It does not indicate, for example, the wide range of options available with many commands, it omits the language and interface features, and it does not encompass the external packages.

**Mathematical graphics:**
Graph of functions of one or two variables; contours and density for functions of two variables; plots of discrete data in two- and three-space; contours and density for data in three-space; parametrized plane curves; animations of sequences of any of the above graphical types.

**Computer algebra:**
Integer and combinatorial functions: Gcd; lcm; factorization into primes; generation of primes; Legendre and Jacobi symbols; reduced lattice basis for a set of integer vectors; Euler totient and Möbius functions; multinomial coefficients; Bernoulli, Euler, and Stirling numbers; partition functions.
Calculus operations: Partial and total derivatives; indefinite and definite integrals; truncated power series and Laurent series; limits.

Polynomial algebra: Expand; factor; combine fractions; cancel common factors; divide; decompose into partial fractions; find gcd and resultant; solve a system of polynomial equations.

Matrix and tensor algebra: Inverse; determinant and minors; solution of a linear system; basis of a nullspace; reduced echelon form; eigenvalues and eigenvectors; inner and outer tensor products.

Numerical routines:
Function evaluation: Elementary transcendental functions; classical orthogonal polynomials; special functions of mathematical physics (including Bessel and hypergeometric); elliptic integrals and elliptic functions; gamma, beta, error, logarithmic integral, exponential integral, digamma, polylogarithm, and Riemann zeta functions.

Operations on functions: Definite integral; infinite sum and product; solution of a single polynomial equation; solution of a system of transcendental equations; local minimum of a real-valued function of several variables.

Matrix routines: Inverse; Moore-Penrose inverse; singular values; solution of a linear system; eigenvectors and eigenvalues for a general real matrix.

Routines for numerical data: Least-squares fit to a linear combination of specified functions; discrete Fourier transform.

Publication Information
Mathematica is published by Wolfram Research, Inc., P.O. Box 6059, Champaign, IL 61821. It lists for $495 on the Macintosh Plus or SE, $795 on the Macintosh II. Educational and volume discounts are available. Also, a special "bundled" price of $50 with the Macintosh Plus or SE and $80 with the Macintosh II will be available at selected academic institutions that agree to include Mathematica with every Macintosh they sell on campus. A minimum of 2 megabytes of RAM is required. One copy of the user manual, Mathematica: A System for Doing Mathematics by Computer, by Stephen Wolfram, accompanies the software. This book is also sold separately by Addison-Wesley Publishing Company (1988, 749 pp., $44.25 for hardcover, $29.95 for paperback). A smaller user manual accompanying the software describes the graphical interface for the target machine. Versions of Mathematica for the Ardent Titan, IBM RT/PC, NeXT, Silicon Graphics Iris 4D, Stellar GS-1000, and Sun 3, 4, and 386i are projected to be available by the time this review appears. NeXT reports that Mathematica will be bundled with its machine.

Other Packages Mentioned
Derive: The Soft Warehouse, Inc., 3615 Harding Avenue, Suite 505, Honolulu, HI 96816.
Maple: WATCOM, 415 Phillip Street, Waterloo, Ontario, CANADA N2L 3X2.
MathScribe: Textronix Laboratories, P.O. Box 500, M.S. 50-662, Beaverton, OR 97077.
PHASER: Springer-Verlag New York, Inc., 175 Fifth Avenue, New York, NY 10010.

Other Comments on Mathematica

Mathematica and Mathematical Research
If Fermat had been using Mathematica, he would never have thought $F_5$ is prime (factored in 0.016 seconds) or that $F_6$ is prime (factored in 12.38 seconds). Gauss could have conjectured the Prime Number Theorem in an afternoon. Ramanujan would have had a field day.

I like Mathematica a lot. It is interactive, generally quick, easy to use, interacts well with your computing environment, and is easily extended with new functions and procedures. The smooth integration of symbolic, numeric, and graphic operations is particularly attractive. The manual is a superb guide to using Mathematica, with examples that delight, such as plotting the Riemann zeta function on the critical line, or computing $e^{\pi \sqrt{163}}$ to enough places to see that it is remarkably close to, but not exactly, an integer. Mathematica should become widely available, including its bundling with the soon-to-be-announced academic workstation from NeXT. It could become a standard for the exchange of algorithms, and indeed for the communication of all sorts of mathematical ideas.
I’ve been running a pre-release version of *SunMathematica* (which is simply *Mathematica* with a graphical interface for computers from Sun Microsystems) for the past few months on a Sun-3/140 monochrome workstation with 12 MB of memory, and my comments are based on preliminary reactions only. With this amount of memory, and the virtual memory of Unix, there haven’t been memory problems running the program. On the other hand, the Macintosh version with its notebooks and other convenient features appears to be a better environment. Part of the problem with SunView is its awkward method of handling text. I would expect a much improved user interface for *SunMathematica* when SunView is replaced by the Open Look windowing system that has been recently announced jointly by Sun and AT&T.

What sorts of things can one do with the program? For certain areas of research, such a program can extend the range of examples that can be analyzed by two or three orders of magnitude. Computer experimentation in this range can reveal new phenomena to be understood and proved. This has happened to me several times during my work on symbolic dynamics. For certain areas of research, such a program can extend the range of examples that can be analyzed by two or three orders of magnitude. Computer experimentation in this range can reveal new phenomena to be understood and proved.

I haven’t been using *SunMathematica* long enough yet for it to have a direct impact on my research, but I’m quite sure it will. However, let me give some flavor of its use. Recently I wanted to know the discriminants of some polynomials in several variables with respect to one of the variables. These are very messy to compute by hand, even for modest degrees. Although *SunMathematica* does not have a discriminant function built in, the Resultant[] function is there, and with a bit of thumbing through the manual it was easy to write my own routine for discriminants:

```math
Discriminant[f_, x_] := (-1)^Binomial
[Exponent[f, x], 2]Cancel[Resultant[f, D[f, x],
x]/Coefficient[f, x^Exponent[f, x]]]
```

Surprisingly, most texts, such as Lang’s, forget to multiply by the sign correction. After debugging, this was stored in a file for future use, with help documentation included. As another example, *SunMathematica* has built in a LatticeReduce[] function for computing the smallest element in a lattice generated by a set of integral vectors. Using this, I wrote an 18-line function that (sometimes) figures out if a given floating point number is really a product rational power of familiar constants like \(\pi\) and \(e\). *SunMathematica* has the same philosophy as Unix, to make available a wide range of powerful tools that fit together well to do lots of useful and unexpected things.

For such a complicated program *SunMathematica* works surprisingly well. There are a few shortcomings that I’ve noticed over the past few months, but most of these have been fixed in the latest release. However, Integrate[ ] fails for some rather simple integrands and gives the wrong answer on some others, Limit[ ] fails on many limits at infinity, and matrices are lists of lists, so it can be awkward, for example, to extract a submatrix. The programmers are eager to repair bugs, and I’m confident that minor problems will be ironed out quickly.

The one real reservation I have is that the manual rarely describes the algorithms used and is in no way a technical reference. The program is thus a “black box” to the user, and I wouldn’t want to base a counterexample to the Riemann Hypothesis solely on one of its calculations. Vague references in the manual to adaptive techniques for numerical integration, for example, are no substitute for explaining the algorithm. As a practical matter, such explanations would no doubt at least double the size of the 900 page manual. However, it would be valuable to have a separate reference manual for *Mathematica* available for those who need to know in more detail what the program is doing. The support staff says there are plans to publish later a series of technical reports on these matters.

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### Mathematica and Me

Two years of computer work for the defense department in the late sixties convinced me that computers were for someone else. When Illinois hired me in 1968, I happily took refuge in Bochner and Pettis integration and martingales in the tranquil atmosphere offered by Banach spaces with the Radon-Nikodym property. Aside from a brief encounter with calculators in the seventies and a new Macintosh SE sitting idly on my desk, I had happily avoided computers for twenty years. Then one day last winter I heard about the *Mathematica™* project at Illinois and stopped by Dan Grayson’s office to see what the fuss was all about. I went back a few more times. Then I realized it: Dropping *Mathematica* into a Macintosh SE is every bit as exciting to me today as GM’s dropping
a big V8 into its “powerslide” Chevies was to me in 1955. With Mathematica, my funny little idle Macintosh could become a mathematical workhorse powered by a big V8 engine! Now my own Macintosh could do for me what I thought computers should have been able to do all the time. My own Macintosh could help me do, teach and write mathematics.

My reaction to Mathematica was by no means unique. Mathematicians are fascinated with it. One battle hardened anti-computer several complex variables fellow in my department worked with Mathematica one night and ordered a MacII the next morning. He had repeated several weeks of his hand calculations in one night of Mathematica.

Mathematica will do arbitrary precision arithmetic, all manner of symbolic calculations and two- and three-dimensional plots; it will do all the hand calculations normally associated with calculus (including derivatives, integrals, Newton’s method and power series), linear algebra and statistics. It can be used as a calculator or as a programming language, and using it is so painless that it blurs the distinction between these two functions. But its real ace in the hole is that it is also a word processor. Its word processing capabilities on the Macintosh allow one to create something called Mathematica notebooks. I’m not sure how to characterize them. They are live electronic documents which are mixtures of static text and live programs that set up an entirely new vehicle for communication of mathematics. Imagine a calculus book in which every example can be modified on the spot to become infinitely many examples, a calculus book that can plot any calculus function, a calculus book that can differentiate, integrate, find roots, expand in power series—in short a calculus book that can teach the students and act as a slave for them. This is what my colleague Horacio Porta and I realized one day last winter.

One bull session grew into another and some encouraging talks with Stephen Wolfram and Dan Grayson took place. It was not long until Porta and I agreed to write a Mathematica calculus notebook. We brought in a top notch engineering physics undergraduate student, Don Brown, to help and the three of us have spent the summer and much of this semester on our new course, Calculus & Mathematica. We have had a lot of fun using the raw computational, algorithmic, symbolic and graphic power of Mathematica as a device for exposition. And Mathematica has not let us down. (There have been a few bugs in the early copies of Mathematica that we have worked with, but soon these bugs will have disappeared.)

The whole course takes place on the screen; there is no loss of train of thought in oscillating between the printed page and the computer. The course directs the students to work out concrete exercises and then to embark in their own computational and graphic explorations. This dynamic integration of text and laboratory components of the course is the key feature and it is possible only with Mathematica. The computer, the pencil and the text merge into one. With Mathematica handling the rote computations, even ordinary students will be able to solve problems far beyond the reach of today’s best students. Furthermore, with Mathematica, the course can be steered in the direction of underlying concepts and more difficult problems than possible in today’s courses.

For example, students when directed to use Mathematica to plot the integrand and the difference quotients for the indefinite integral of the integrand can have little doubt about the meaning of the fundamental theorem. Students who write a financial planning package should have little doubt about the role that the number e plays in compound interest. Students who have seen the lower Riemann sums fill up the area under the curve of their own choice on a Mathematica animation should have little hesitation with the idea of the definite integral as a limit of Riemann sums. Students who have seen \((f'(x + h) - f'(x))/h\) converge uniformly to \(f'(x)\) as \(h\) tends to 0 for the (well-behaved) function \(f\) of their choice on a Mathematica animation should have little doubt about the definition of the derivative. Students who program Mathematica animations for the convergence of Taylor and Fourier series should no longer fear these topics the way students of today fear them. Students who can quickly determine that the maximum and minimum values of \((1 - 2x)^2(x - x^2)(1 - 8x + 8x^2)^2\) on \([0,1]\) are 1/64 and 0 respectively should have few problems with generic max-min problems. At the end of the article, you will find a short Mathematica code which solves this problem (which appeared in the May 1988 issue of the College Mathematics Journal).

With the introduction of Mathematica notebooks as live electronic texts, I believe Mathematica will revolutionize undergraduate mathematics. When this happens, undergraduate mathematics in America will reach Lynn Arthur Steen’s goal of becoming more like real mathematics both in the industrial workplace and in academic research.

Example: (Using Mathematica to maximize and minimize \((1 - 2x)^2(x - x^2)(1 - 8x + 8x^2)^2\) on \([0,1]\).)

To maximize and minimize \(y\) on \([0,1]\), we differentiate, find the critical points, and evaluate \(y\) at each
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critical point. Then we check to see which critical points are in [0,1] and then evaluate $y$ at each end point to make our final determination.

$$y = (x - x^2)^2 (1 - 2x)^2 (1 - 8x + 8x^2)^2$$

```mathematica
criticalpoints = Solve[D[y, x] == 0]
Simplify[y /. criticalpoints]
```

{0, 0, 0, --, --, --, --}
64 64 64 64

At this point we know the value of $y$ at each critical point is either 0 or 1/64. Now we find the location of the critical points to 10 places:

```mathematica
N[x /. criticalpoints, 10]
```

{0.5, 0.8535533906, 0.1464466094, 0.9619397663, 0.03806023374, 0.6913417162, 0.3086582838}

They are all in the interval [0,1]. Because $y$ is 0 at the end points we conclude the maximum value of $y$ is 1/64 and the minimum value is 0 on [0,1].

If we want, for example, the exact specification of the fifth critical point, then we can fish it out:

```mathematica
criticalpoints[[5]]
```

16 - Sqrt[256 - 64 (2 - Sqrt[2])] /------------------
32

Observe that Mathematica neither interfered with nor replaced the mathematics underlying this solution. It did replace the difficult, tedious hand calculations needed to do this problem. Does anyone really want to do this problem by hand?

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**Mathematica in Undergraduate Mathematics**

Introduction

Mathematica and other “computer algebra systems”** offer important new possibilities for mathematical teaching and learning. They offer, for the first time, a kit of powerful mathematical tools—graphical, algebraic, and numerical—at acceptable cost in time and distraction. Using such tools, we and our students can represent and manipulate mathematical ideas more efficiently, effectively, and flexibly than before. At a minimum, Mathematica and other systems offer computational leverage. At best—and I believe we can expect this—Mathematica can help us foster genuinely deeper understanding of mathematical ideas.

My experience with computer algebra systems in undergraduate mathematics began several years ago, before Mathematica existed. At present, the mathematics department at St. Olaf College, where I teach, is in the middle of a three-year calculus curriculum development project**, in which students and faculty use the computer algebra system SMP regularly and heavily. Although our students do not—at the moment—use Mathematica, I will briefly describe the project, both to illustrate generally how and why we use a powerful computer mathematics system, and to speculate on the special advantages Mathematica would offer in an environment like ours.

The St. Olaf Calculus Project

Several special sections of elementary calculus are taught each semester at St. Olaf. (Students select themselves into the project sections.) Students in the project sections use SMP, on Sun-3 workstations, to complete specially-prepared homework sets and, sometimes, in taking examinations. No previous computing experience is expected; programming plays no role whatever in the courses. Ideally, SMP operates as a pure mathematical tool, never calling attention to its own workings.

A few local features were added to SMP, among them a simple help system (the built-in system said too much) and several commands for numerical methods. For instance, commands for numerical integration, similar to the one illustrated in the sample exercise below, were written locally.

The set of topics covered in project sections is not radically out of the ordinary. “Hand” techniques, for instance, though perhaps somewhat de-emphasized, are by no means abandoned. A few non-standard topics, such as elementary numerical methods for integration and root-finding, are covered. The most distinctive features of the project sections, though,

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* The umbrella term “computer algebra system”, although standard, is misleading. Programs known by that name do much more than algebra.

** The project is supported by NSF’s Instructional Laboratory Instrumentation Program (formerly the College Science Instrumentation Program) and by the U.S. Department of Education’s Fund for Improvement of Postsecondary Education.
probably have to do with general viewpoints: to emphasize calculus ideas over mechanics, and, especially, to draw freely on geometric, numerical, and algebraic methods for learning, illustrating, and applying ideas. Thus, e.g., graph-sketching itself is downplayed, but computer graphics are used freely to show and emphasize connections between analytic properties of a function and geometric properties of its graph.

The most important concrete goal of the project is to supplement the usual narrowly algebraic approach to the calculus with numerical and graphical viewpoints. (It is perhaps ironic that computer algebra systems should support this goal.) The definite integral, for example, is for many students not a number, defined as a limit, but rather an algebraic process: antidifferentiate and plug in the endpoints. When closed-form methods fail, there is little recourse. Numerical and graphical approaches to the definite integral are not only better at “getting answers”; more important, they also lead to deeper and more useful understanding of the integral as an analytic object.

**A Mathematica Example**

Students in our project work exercises like the one below. (They use SMP rather than Mathematica syntax; at this level, the differences are small.)

**Exercise:** Suppose \( f(t) = \sin(t^2) \) and \( F(x) = \int_0^x f(t)\,dt \).

*a.* Estimate \( F(1) \) in two ways: first geometrically, as area under a graph. How accurate can your estimate be? Next, approximate \( F(1) \) using a midpoint sum with 10 subdivisions.

*b.* In order to obtain a graph of \( F(x) \) on \([0,3]\) we need many (approximate!) values of \( F \). Let Mathematica do the work, as follows: Give the Mathematica commands

\[
F[x_] := \text{Midpoint}[\sin[t^2], t, 0, x, \text{10}]
\]

\[
\text{Plot}[F[x], \{x, 0, 3\}]
\]

(The first command defines a function \( F \) that numerically approximates \( F \). The second command sketches a graph of \( F \).) Discuss the relationship between \( f \) and \( F \), by examining graphs of both functions.

Notice that the problem uses modern technology for an entirely traditional purpose: to reinforce the connection between derivative and integral. The effect is not to “automate” the course, but to focus it more clearly on central ideas.

**Mathematica, SMP, and Other Systems**

The St. Olaf project, and hence our choice of SMP, predates Mathematica; SMP continues to perform satisfactorily. Our project, driven as it is by the curriculum rather than by software, would not change radically if we adopted *Mathematica* (or, for that matter, Maple, Macsyma, or Reduce.) Nevertheless, *Mathematica* would offer us several advantages.

1. We originally chose SMP partly for its graphics. *Mathematica*'s graphics are significantly better. For example, *Mathematica* permits full use of graphical window tools: resizing, moving, saving plots, etc.

2. St. Olaf students appear to learn SMP syntax and a sufficient (for calculus) repertoire of commands with a significant but not unreasonable (and certainly not wasted!) expenditure of effort.

3. For the student's sake, program output should appear in “familiar” forms. SMP can be weak in this respect: complex exponentials sometimes crop up in apparently harmless trigonometric integrals. *Mathematica*'s results look more standard.

4. Whether students formally write programs or not, realizing simple mathematical algorithms should be easy and mathematically natural. This is certainly true in *Mathematica*. Here, for instance, are “programs” for several numerical integration rules.

(The - and _ characters on the left sides arise in function definitions.)

\[
\text{Left}[f_, x_, a_, b_, n_] := \\
\text{Sum}[f / . x \to a + (b - a)/n*i, \\
\{i, 0, n - 1\}]*(b - a)/n
\]

\[
\text{Right}[h_, x_, a_, b_, n_] := \\
\text{Left}[h, x, a + (b - a)/n, \\
b + (b - a)/n, n]
\]

\[
\text{Midpoint}[f_, x_, a_, b_, n_] := \\
\text{Left}[f, x, a + (b - a)/2*n, \\
b + (b - a)/(2*n), n]
\]

\[
\text{Trapezoid}[x_] := (\text{Left}[x]+\text{Right}[x])/2
\]

\[
\text{Simpson}[x_] := \\
(\text{Trapezoid}[x]+2*\text{Midpoint}[x])/3
\]

The effort, be it great or small, of learning to use a sophisticated program is best amortized over more than one course. This is certainly possible with systems like *Mathematica*. In complex analysis, for example, *Mathematica*'s graphics could be quite enlightening. Given an analytic function \( f = u + iv \), a student could see the surfaces corresponding to the real functions \( u, v \), and \( f \), and see directly the geometric meaning of the Cauchy-Riemann equations, harmonicity, and the maximum modulus principle.
Computing in mathematics courses is nothing new. What— is— new is the chance to compute for mathematical insight, at acceptable cost in distraction.

Conclusion

Computer mathematics systems can be important tools for more efficient and ultimately deeper mathematical learning. By handling straightforward but computationally expensive operations, they can allow more and more varied examples and exercises, promote geometric intuition, and encourage active, experimental attitudes toward mathematics. A useful system should combine algebraic, numerical, and graphical computing power, be possible for students to learn and use effectively, and repay the effort of learning it throughout the student’s mathematical career. In all these respects, Mathematica is an excellent example.

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For the Love of Mathematics

First, let me say that while I am a mathematician, and have been extensively involved with computers for the past decade, Mathematica is the only mathematics computer system I have used for more than a few hours. So I am in no position whatsoever to make any comparisons.

Second, the program claims to tackle all of mathematics. But Wolfram seems to have a physicists view of “all of mathematics.” The packages that come with the current version of Mathematica implement very classical mathematics, not the sort of thing that interests a mathematician interested in algorithms on strings or graphs, say. Since I am a logician, this emphasis left me initially somewhat disappointed with the program.

However, this disappointment has passed and has been more than compensated for in using the program. First, Mathematica reawakened my interest in a host of classical topics. My feeling of wonder recalled the thrill I had as a high school student thirty years ago reading books like Courant and Robbins. The program really makes mathematics, or those parts it covers, come alive. Maybe other mathematics programs have the same effect on their users. But what I would have given as a teenager falling in love with mathematics to have had a tool like this. (Of course, with the high price, I would never have been able to afford it.)

Second, even though Mathematica’s prepackaged algorithms are all pretty classical, Mathematica’s language, a Lisp-like string language, seems very clean and elegant. It definitely appealed to the logician in me. I was able to start programming (admittedly simple programs) in it at first sitting. I would love to have a year off to sit and use the program, both to explore various mathematical topics it already covers, but also to do some programming in it related to my own area of research, a temptation I have managed to avoid until now.

Third, I really like Mathematica’s “notebook” idea. Using it one is able to write mathematical documents in a really different style, where the reader can use the program in an interactive way. A short leap of the imagination takes one to research notebooks where proofs are outlined, with details to be filled in by the computer on demand.

However, in its initial release the program is often very frustrating, as Herman’s review should make clear. I use the program on my Mac II with 4 MB of memory, and it still crashes frequently from lack of memory. At least I suppose it is lack of memory. The crashes are often so ungraceful that I really have no idea what has gone wrong. Another annoyance is that when the program gets into an infinite loop, it is often impossible to exit without completely rebooting the machine, and so losing all the work since the last “save.” And the loops are not always my fault.

I wonder if it was wise to release the program in such an unstable state. But maybe any program which aims at such a wide coverage is going to have a lot of bugs until it is used by a lot of different sorts of users. Wolfram Research Institute plans to release a new version, 1.1, in the near future. Presumably a lot of the bugs pointed out by users will be ironed out with that release. And anyone with a registered copy of the program will automatically receive the new version.

Another concern I have is the high price of the program, currently about $800 for the Mac II. But maybe any program which aims at such a wide coverage is going to have a lot of bugs until it is used by a lot of different sorts of users. Wolfram Research Institute plans to release a new version, 1.1, in the near future. Presumably a lot of the bugs pointed out by users will be ironed out with that release. And anyone with a registered copy of the program will automatically receive the new version.

Another concern I have is the high price of the program, currently about $800 for the Mac II. But this is just part of my general concern with the high price of software, and the whole problem of the illegal copying of software. But in the mean time I am not complaining. I got my review copy of Mathematica free, and it has reawakened a love of the classical parts of mathematics that had all but died.

Jon Barwise
Stanford University
Research mathematicians have been paying more attention recently to questions of mathematics education, and there has also been a growing curiosity about the mathematical culture of Hungary. These two interests were focused this summer on a pair of international meetings on mathematics education that took place in Hungary during July and August. The twelfth annual meeting of the International Group for the Psychology of Mathematics Education (PME) was held at the Chemical University of Veszprém near Lake Balaton from July 20 through 25 and the sixth quadrennial International Congress on Mathematical Education (ICME-6) was held in Budapest at the Technical University from July 27 through August 3. This article presents summaries and highlights of the two conferences.

PME 12

The International Group for the Psychology of Mathematics Education was founded for the purpose of promoting international contacts and exchange of information in the psychology of mathematics education, of stimulating interdisciplinary research amongst psychologists, mathematicians and mathematics teachers, and of furthering an understanding of the psychological aspects of teaching and learning mathematics. PME originated in 1972 as a working group at the Second International Congress on Mathematical Education and has been affiliated since 1976 with the International Commission for Mathematical Instruction (ICMI) which is a commission of the International Mathematics Union (IMU).

Of particular interest to members of AMS, perhaps, is PME's working group on Advanced Mathematical Thinking which meets annually for presentations, discussions and the planning of a major treatise on teaching and learning mathematics at the post-secondary level.

The annual conference of PME consists of plenary sessions, individual research presentations, and working and discussion groups on current topics. About 200-300 people attend these meetings and many of them come regularly so that there is the opportunity to develop ongoing professional relationships at an international level.

The plenary addresses opened each daily session this summer and included the following authors and topics: Terezhina Carraher of Brazil, “Street mathematics and school mathematics”; Sándor Klein and Gusztaáv Haberman of Hungary, “A look at the affective side of mathematics learning in Hungarian Secondary Schools”; Perla Nesher of Israel, “Beyond constructivism”; and Leen Streefland of the Netherlands, “Reconstructive learning”.

Following the morning plenary sessions were blocks of time set aside for the presentation of reports on individual research activities. These are refereed papers and run for 40 minutes each, about evenly divided between presentation and discussion. The approximately 70 papers accepted for this meeting were grouped in 6 topics: computer environments, teacher's beliefs, problem solving, social factors, early numbers and arithmetic, and rational numbers.

The working and discussion groups met once or twice daily and provided an ongoing topical focus for PME participants. The working groups were established to promote ongoing communication among PME members between meetings and continuity over a period of years. This summer's groups focused on the topics of advanced mathematical thinking, geometry, the role of representations in acquiring mathematical knowledge, research on teacher education, and the role of counting in the development of arithmetic skills. A discussion group is a “pre-working group” meeting annually until it is sufficiently established to be declared a working group by the International Committee of PME.

The annual meeting of PME was concluded with a general assembly to elect officers and new members of the International Committee. It also considered various issues that were put before it.
The participants of the annual meeting of PME generally come away with good feelings of camaraderie as well as identification with and information about the efforts of colleagues studying in similar areas. The meeting benefits from its relatively small size, its varied international settings, and its unique living arrangements that encourage social interaction during meals, off-moments, and evening activities.

PME 13 will be held in early July next summer at the Sorbonne in Paris.

**ICME-6**

The International Congress on Mathematical Education is a very different sort of meeting from that of PME. Held every four years, it brings together people who are concerned with research, with teaching practice and with the organization of mathematics education in their countries. It is organized under the sponsorship of ICMI and this year was hosted by the János Bolyai Mathematical Society with the cooperation of the Hungarian Academy of Sciences and the Hungarian Ministry of Education and Culture. The Congress was very well attended with about 2500 participants.

Given such a large number of participants with such disparate backgrounds, it is not surprising that the scientific program was relatively complex and difficult to comprehend. There were Action Groups, Theme Groups, and Topic Groups each playing subtly different roles. There were Plenary Lectures, Theme Group Survey talks, National Presentations, Short Communications, International Study Groups and Poster Presentations.

The General Information and Program document for the meeting is a booklet of 64 pages and it was considered to be required reading for anyone who wanted to avoid being totally lost, both geographically and intellectually. Fortunately, this booklet was considered to be required reading for anyone who wanted to avoid being totally lost, both geographically and intellectually. Fortunately, this booklet was constructed with care and intelligence so, if one spent some time with it and prepared a little before each day, it was possible to develop a feeling for what was going on and how to choose from such a potpourri of activity.

Participants at ICME-6 selected their areas of interest within the various action, theme and topic groups and then attended daily sessions in these areas as on-going structures for their conference days. The action groups met each morning to discuss issues of mathematics education within the age levels of early childhood, elementary, junior high, secondary, tertiary and adult years as well as within teacher education programs. Seven theme groups met each afternoon on the topics of the teaching profession, computers, problem solving, assessment, the curriculum of the future, research and practice, and connecting mathematics with other subject areas. Eighteen topic groups met daily on such issues as video and film, handicapped students, probability and statistics, proofs, language and mathematics, spaces and geometry, women and mathematics, students of high ability and theory of mathematics education. Each of these different kinds of groups was autonomous and they organized themselves in different ways, each with some mix of presentation, discussion and demonstration.

There was an entire day set aside during the congress to concentrate on sociological and political issues related to mathematics education. Such a focus for a full day was unprecedented at ICME-6 and thus reflected the concern of the education community with the economic, political, and sociological impacts of mathematics knowledge on human welfare. The day was organized into presentations and audience discussions by Alan Bishop of Great Britain, Peter Damerow of West Berlin and Paulus Gerdes of Mozambique. The talks centered around the topics of mathematics education and culture, society and institutionalized mathematics education, educational institutions and the individual learner, and mathematics education in the global village.

The ICME-6 program consisted also of plenary addresses, national presentations, short communications, international study groups, and poster sessions. The three plenary addresses were by Bienvenida F. Nebres of the Phillipines, Gerard Vergnaud of France, and László Lovász of Hungary. There was also a special invited lecture by Andrei Ershov of USSR and the presidential address by Jean-Pierre Kahane of France.

Nebres spoke about the challenge for change in school mathematics in the 1990s with special emphasis on the situation in developing countries. Lovász spoke on the new modern emphasis on algorithmic mathematics which has been with us for a long time but appears today in a new light. The talk of Vergnaud was an overview of the role of theory in mathematics education research and a plea for workers to base their activities on a theoretical framework.

Academician Andrei Ershov is head of the Department for Informatics in the Computing Center and Professor of Computer Science at Novosibirsk State University. He has been in charge of many projects concerning computers, including the Soviet Union's educational computing system. Ershov gave a long and detailed survey of the use of computers for education in the Soviet Union. He also spoke at length about the Russian experience with "new math" and was quite
For Your Information

definite about its failure which appeared to be as serious as in the US and for much the same reasons.

Jean-Pierre Kahane, the president of ICMI, which sponsors the ICME meeting, and an honorary member of the Hungarian Academy of Sciences, spoke about the life and mathematical work of George Pólya. He emphasized the contributions of this great Hungarian figure to both mathematics and mathematics education.

ICME-6 included a number of social and cultural events including excursions on the Danube, visits to small towns, and a reception and concert at the National Gallery of Hungary. Most of the scientific program, except for the plenary addresses, took place at the Technical University situated in Buda (which is what one side of the river is called) at the foot of the famous Gellért Hill overlooking the Danube. Participants at the Congress spent their free moments enjoying the beautiful summer days in the shady gardens behind the University, watching the Danube river traffic out front, or conversing with colleagues at the late afternoon social hours. The excellent transportation system of Budapest permitted easy access to open-air markets, monuments, museums, concerts, parks and panoramic views.

ICME-7 will be held in Quebec in 1992.

The Collected Papers of
R. H. BING

Sukhjit Singh, Steve Armentrout, Robert J. Daverman, Editors

A powerful mathematician and a great problem solver, R. H. Bing laid the foundation for a number of areas of topology. Many of his papers have continued to serve as a source of major theoretical developments and concrete applications in recent years. One outstanding example was Michael H. Freedman’s use of Bing’s Shrinking Criterion to solve the four-dimensional Poincaré Conjecture.

This two-volume set brings together over one hundred of Bing’s research, expository, and miscellaneous papers. These works range over a great variety of topics in topology, including the topology of manifolds, decomposition spaces, continua, metrization, general topology, and geometric topology. In addition, there are a number of papers in the areas of convex functions, linearity, and conformal varieties. The introductory section in the first volume provides historical background on Bing’s life and achievements.

This collection will appeal to mathematicians in all areas, and especially those in topology, as well as students, historians, and educators in the mathematical sciences, for it provides a complete historical summary of the mathematical events in the life of the man and the mathematician, R. H. Bing.

Contents:
I. R. H. Bing: An introduction; An editorial preface; R. H. Bing: A study of his life, by S. Singh; A chronology of R. H. Bing; Ph.D. students of R. H. Bing; R. H. Bing: October 20, 1914–April 28, 1986, by R. D. Anderson and C. E. Burgess; Abstracts by R. H. Bing; II. Papers of R. H. Bing; III. Classifications of works of R. H. Bing; Publications of R. H. Bing: Classified by the year; Publications of R. H. Bing: Classified by subject matter; Works not included in these volumes; Permissions.

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News and Announcements

MacArthur Prize Awarded

The John D. and Catherine T. MacArthur Foundation has announced the selection of 31 new MacArthur Fellows. The present group includes one theoretical and experimental physicist, Robert S. Shaw of the University of Illinois at Urbana-Champaign. This announcement brings to 254 the number of Fellows named since the program began in 1981. The Foundation does not accept applications for Fellowships. Instead, anonymous nominators recommend Fellowship candidates to an independent selection committee. There are no set times for announcements or yearly quotas of Fellows. The awards range from $150,000 to $375,000 over five years, depending upon the age of the recipient.

Unlike conventional grants, the MacArthur Fellowships impose no requirements, restrictions, or performance standards on the Fellows. Among the several categories of individuals who are most likely to benefit from this particular award are the young, who need freedom from economic burdens which may force them into the predictable routines of standard career patterns; those in mid-career who wish to change fields, a move discouraged by many employers; those older people who lose or never had institutional support but have important work to continue; those whose interdisciplinary work cannot fit existing funding patterns; those who are outside the usual institutional networks and career patterns, or in remote areas; those involved in unconventional or seemingly obscure but in fact important endeavors; and those engaged in or planning courageous “long shots” which, because of the risk of no payoff, cannot get support from other granting agencies.

Robert S. Shaw is a theoretical and experimental physicist who works on information flow in chaotic and dynamical systems. Currently, he is developing a new language for the nonequilibrium statistical mechanics of spatially extended systems. To undertake his research, he frequently builds his own computers or revamps existing ones.

Dr. Shaw is a Fellow of the Center for Complex Systems Research at the University of Illinois, Urbana-Champaign. He received his B.S. degree from Harvard University in 1972 and his Ph.D. in 1980 from the University of California, Santa Cruz. Forty-one years old, he will receive a total of $260,000 from the MacArthur Foundation.

Kyoto Prize Laureates Announced

Three individuals have been named as recipients of the 1988 Kyoto Prizes. Among the recipients are two researchers having strong connections to the mathematical sciences: Noam Avram Chomsky of the Massachusetts Institute of Technology and John McCarthy of Stanford University.

Kyoto Prize laureates receive academic honors and a cash award of 45 million yen (approximately $340,000). The awards will be made on November 9-12, 1988, in Kyoto, Japan.

The Kyoto Prizes are international awards honoring people who have contributed significantly to the scientific, cultural, and spiritual development of mankind. Candidates are chosen by official Kyoto Prize nominators, who are internationally recognized authorities in their respective fields. A candidate must be an expert in his or her field, possess a strong and positive individual philosophy, have made significant contributions to the advancement of his or her field, and have exerted a great and positive influence on the world.

There have been two previous Kyoto Prize laureates in areas having connections to the mathematical sciences. In 1985, Rudolf Emile Kalman received the Kyoto Prize in Advanced Technology for forming the foundation for most of today’s work in control engineering, information engineering, and computer science. In that same year, Claude Elwood Shannon was awarded the Kyoto Prize in Basic Sciences for work in information engineering which has...
created new inroads in assessing the quantity and reliability of information, including information transfer, based on pure mathematical analysis.

**NOAM AVRAM CHOMSKY**, best known as the leader of modern linguistics, will receive the 1988 Kyoto Prize in Basic Sciences. His achievements include the “Generative Grammar Theory,” in which he integrated contemporary psychology, information science, and neurophysiology with computer-related disciplines. This discovery has provided insights into the reasoning abilities of the human brain itself.

The essence of Professor Chomsky’s “Generative Grammar Theory” is based on the concept that all human languages share general principles on a deep level, in spite of their superficial diversity. The theory views linguistic syntax in a dynamic manner, as a rule of structure for generating sentences—a notion which created a major uprising in the field of linguistics. However, Professor Chomsky supported his theory with a symbolic system formulated with precise mathematical parameters. This theory has since become the basis for the further development of computer and information sciences. In addition to his academic distinction, Chomsky has proved himself to be a sincere humanitarian who promotes peace and global well-being.

Born December 7, 1928, Noam Chomsky received his doctorate in linguistics in 1955 from the University of Pennsylvania. He has received honorary degrees from the University of London, the University of Chicago, and Delhi University in India, among other institutions. In 1984, he received the APA Award for Distinguished Scientific Contributions from the American Psychological Association. He is a fellow of the British Psychologist Association and a member of the National Academy of Sciences. He is presently Institute Professor at the Massachusetts Institute of Technology.

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**Professor Noam Avram Chomsky**

**JOHN McCARTHY**, a pioneer in the field of computer science, will receive the 1988 Kyoto Prize in Advanced Technology. He is one of the original researchers of self-governing systems and is one of today's most accomplished authorities on artificial intelligence (AI). His publication of *Automata Studies* in 1956 with Claude Shannon had a profound influence on the study of self-controlled systems and robotics throughout the mid-1950s and 1960s. In 1968, Professor McCarthy published *Programs with Common Sense*, an investigation into methods of formalizing logic to help provide computers with a reasoning capability comparable to that of humans.

One of the problems facing the field of AI at that time was an inherent deficiency in conventional programming languages, which were based on numerical processing. Realizing that these languages could not meet the requirements of increasingly advanced AI applications and research, Professor McCarthy created Lisp, a new programming language which opened the door to the era of fast and effective symbolic processing. In addition, Professor McCarthy is the creator of TSS, or the Time Sharing System, which has given rise to most of the large-scale computer systems in use around the world today.

Born September 4, 1927, John McCarthy received a doctorate in mathematics from Princeton University in 1951. He was a National Lecturer for the Association for Computing Machinery (ACM) in 1961 and received the A. M. Turing Award from ACM in 1971. In 1985, he was presented with the Research Excellence Award at the International Joint Conference on Artificial Intelligence.

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**Professor John McCarthy**

**Salem Prize**

The Salem Prize for 1988 was awarded to Dr. A. L. Vol'berg (LOMI, Leningrad) for his work on rational approximation and almost analytic functions and to Dr. Jean-Christophe Yoccoz (École Polytechnique and Université de Paris-Sud, Orsay) for his work on diffeomorphisms of the circle and Siegel's linearization theorem. The prize, established in 1968, is given every

**Undergraduate Mathematics Education Newsletter Begins Next Year**

*UME Trends: News and Reports on Undergraduate Mathematics Education* is scheduled to appear in March 1989. An indication of the Society’s commitment to collaborative efforts in education, the bimonthly newsletter will be produced in cooperation with the Mathematical Association of America (MAA) and the Society for Industrial and Applied Mathematics (SIAM). The first three years of *Trends* will be partially supported by a grant from the National Science Foundation.

The purpose of *Trends* is to provide a way to keep abreast of developments in mathematics education at the undergraduate level. The newsletter will contain a balance of short, newsy items and longer, more substantive pieces on important issues in undergraduate mathematics education. *Trends* will include such items as articles on educational developments in mathematical sciences departments, descriptions and evaluations of innovative educational programs, opinion pieces, capsule reviews of noteworthy education articles, current information on activities at the National Science Foundation, and education news of interest to the broad mathematical sciences community.

Ed Dubinsky, professor of mathematics and education at Purdue University, has been appointed editor of the newsletter. Dubinsky invites the mathematical sciences community to contact him with suggestions for material that might appear in *Trends* and for topics and authors of articles. “I am particularly interested in volunteers to help gather news on undergraduate mathematics education,” he says. He can be reached at: Mathematics Department, Purdue University, West Lafayette, Indiana 47907; telephone 317-494-1982; electronic mail: bbf@cc.purdue.edu.

Dubinsky sees *Trends* as playing a number of different roles. “It is my hope that *Trends* will provide a forum for discussion and dissemination of ideas and information regarding undergraduate mathematics education,” he says. “I also hope that it will provide an outlet for important material that does not now have any vehicle for dissemination to a wide audience within the mathematical profession and that it will be an exciting, informative, and useful publication that serves the mathematical sciences community.

“The fact that the three major U.S. professional societies in mathematics have joined together to publish this newsletter marks a significant step towards the goal of bringing the problems of undergraduate mathematics education to the attention of mathematicians concerned with research, applications, and industry, as well as those concerned with teaching,” says Dubinsky.

A joint AMS-MAA-SIAM committee was appointed to advise Dubinsky in the formulative stages of *Trends*. The members of the committee are: Jerry L. Bona, Pennsylvania State University; James W. Daniel, University of Texas at Austin; Joseph A. Gallian, University of Minnesota, Duluth; Frank Morgan, Williams College; and Samuel M. Rankin, Worcester Polytechnic Institute.

During 1989, *Trends* will be sent free of charge to all members of the three societies, the American Mathematical Association of Two-Year Colleges, and Psychology of Mathematics Education, as well as all high school teachers who teach advanced placement mathematics courses. In 1990, those who request it will continue to receive the newsletter for free, and the following year, a low subscription price will be introduced.

**Joint Soviet-American Symposium**

A joint Soviet-American symposium, “Frontiers of Mathematics,” co-sponsored by the USSR Academy of Sciences and the New York Academy of Sciences, will be held in New York City on December 15, 16, 17 and 19.


For program and registration information, please write to: Conference Department, The New York Academy of Sciences, 2 East 63rd Street, New York, New York 10021.

**Conference for Refusenik Scientists**

The sixth in a series of international conferences for Soviet “refusenik” scientists will be held in Moscow in December. These scientists have been excluded from, or allowed only
limited access to, official scientific research in the USSR.

The last of these conferences, held in 1980 in Moscow, brought together about 30 Soviet refusenik scientists. Also present were four American scientists, including mathematician Joel Lebowitz of Rutgers University, and 22 other scientists from England, Sweden, Norway, France, Holland, and Mexico. In 1981, Soviet authorities aborted a conference the refuseniks had planned, and this year's conference is the first attempted since then.

The refusenik scientists are mostly Jews who have applied to emigrate from the USSR. Their exclusion from Soviet science is generally interpreted as punishment for their wishing to leave the Soviet Union. Most of the scientists are unemployed, but a few have lower-level jobs that limit their contact with scientific research.

On the Soviet organizing committee for this year's conference are Mark Berenfeld, Yuri Cherniak, Eduard Nadgornyi, and Igor Uspenskii. As of this writing, ten Soviet refuseniks had been scheduled to present papers at the conference, though more are expected to participate. There will probably be 2-4 Western scientists and another 15-20 from Europe. The conference will be held in the apartments of two of the Soviet organizers.

The conference is sponsored by the Committee of Concerned Scientists, which is co-chaired by Lebowitz. The Committee is an independent organization of 5000 American scientists dedicated to the protection and advancement of the human rights and scientific freedom of their international colleagues.

The conference, entitled "Frontiers of Science," will be held December 8-10, 1988 in Moscow. Those who wish to attend the conference or to obtain more information should contact the Committee of Concerned Scientists, 330 Seventh Avenue, Suite 608, New York, NY 10001; telephone 212-695-2560.

Eleventh U.S. National Congress of Applied Mechanics

The Eleventh U.S. National Congress of Applied Mechanics will be held on May 21-25, 1990, at the University of Arizona, Tucson, Arizona. Sessions are being planned for general lectures, symposia, and contributed papers covering all aspects of research which are of general interest to the Applied Mechanics Community. Contributed research papers will be selected from 300-word summaries which must be submitted for consideration prior to October 31, 1989.

Inquiries regarding the Congress may be addressed to Professor C.F. Chen, Department of Aerospace and Mechanical Engineering, University of Arizona, Tucson, Arizona 85721.

The U.S. National Congress of Applied Mechanics is organized by the United States National Committee on Theoretical and Applied Mechanics under the general sponsorship of the National Academy of Sciences and the National Academy of Engineering. Cooperating Societies are: the American Society of Civil Engineers; the American Society of Mechanical Engineers; the American Mathematical Society; the American Institute of Chemical Engineers; the American Physical Society; the American Institute of Aeronautics and Astronautics; the Society for Experimental Stress Analysis; the American Society for Testing and Materials; the Society of Rheology; the Society for Industrial and Applied Mathematics; and the Society for Naval Architects and Marine Engineers.

New AWM Executive Director Appointed

Patricia N. Cross was recently appointed Executive Director for the Association for Women in Mathematics (AWM). The AWM, founded in 1971 with over 2,400 members, encourages women to enter careers in mathematics and promotes equal opportunity and equal treatment of women in the mathematical community. As Executive Director, Cross will be involved in fundraising, membership development, and the administration of the AWM office, which is located at Wellesley College. She replaces Lori Kenschaft, who left the position to pursue a graduate degree at the Harvard Divinity School.

Prior to joining AWM, Cross was with the American Mathematical Society in the Providence office, most recently as the AMS Centennial Coordinator.

Errata

The following errors have been brought to our attention in the list of fifty-year AMS members that appeared in the July/August issue of Notices. Patricia N. Cross was recently appointed Executive Director for the Association for Women in Mathematics (AWM). The AWM, founded in 1971 with over 2,400 members, encourages women to enter careers in mathematics and promotes equal opportunity and equal treatment of women in the mathematical community. As Executive Director, Cross will be involved in fundraising, membership development, and the administration of the AWM office, which is located at Wellesley College. She replaces Lori Kenschaft, who left the position to pursue a graduate degree at the Harvard Divinity School.

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Errata

The following errors have been brought to our attention in the list of fifty-year AMS members that appeared in the July/August issue of Notices. The name John Dyer should have been John Dyer-Bennet. Paul S. Dwyer and Edward D. McCarthy have been deceased for several years. Eric Reissner should have been included in the list.
ANNOUNCING

A new publication...that you are already familiar with

Assistantships and Graduate Fellowships
in the Mathematical Sciences, 1989-1990

Separate Publication

Assistantships and Graduate Fellowships in the Mathematical Sciences, 1989-1990, is now a separate, stand-alone publication of the American Mathematical Society (and no longer the December issue of the Notices).

As a new publication, A&F will continue to provide vital information about university graduate mathematics programs as it has in the past. In addition, it will include information on thesis and foreign language requirements within each listing.

Up-To-Date

The up-to-date information contained within the pages of A&F is compiled from data supplied by university departments. The list of assistantships and graduate fellowships includes approximately 316 departments of mathematics, applied mathematics, statistics, computer science, and related mathematical disciplines; these represent about 239 colleges and universities. A section on stipends for study and travel and addresses of sources of graduate fellowship information is also included.

Wide Distribution

The new A&F will have a wide distribution—departments who are institutional members of the AMS as well as departments that have submitted a listing for the publication will receive complimentary copies of the issue. Institutions that place advertisements will also receive copies of A&F. Individual members of the Society may purchase copies at a substantial discount.

Future issues will be expanded to include data on bachelor's as well as master's and Ph.D. level degree programs. The expanded version of A&F will be offered to high schools as an aid in college admission guidance.

Due December 1988, approx. 100 pages, updated annually
ISBN 0-8218-0126-0
List price $15, Individual member $9
To order, please specify ASST/89NA

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The October issue of Notices provided brief information about Congressional approval of the NSF Appropriation for Fiscal Year 1989. At that time, distribution of the funds below the aggregate Foundation level was not known.

Recently, Congress approved the National Science Foundation’s Current Plan for Fiscal Year 1989. This plan distributes the appropriated funds to the directorate and divisional levels. Funds in the Research and Related Activities Account increased from $1,453 million to $1,583 million, an increase of 8.9%. Within that category, funding for the Mathematical and Physical Sciences Directorate increased from $473.04 million to $492.43 million, an increase of 4.1%. Science and Technology Centers, a major initiative of the Foundation, will be funded in Fiscal Year 1989 at a level of approximately $25 million.

The Current Plan allocation for the Division of Mathematical Sciences for Fiscal Year 1989 is $66.24 million, an increase of 4.0% from the Fiscal Year 1988 total of $63.67 million. The two letters that follow describe evolving plans of the Division to enhance particular aspects of its activities.

Open Letter on Fostering Interaction
Dear Colleague:
In a number of areas of science and engineering, problems of great mathematical complexity or subtlety are creating a demand for serious mathematical cooperation. The depth of the questions being raised often exceeds that of the training of scientists and engineers in current mathematical theory. To make headway on the problems, mathematicians themselves must be sought out to work in tandem. At the same time, it is frequently the case that the problems posed raise interesting and deep mathematical questions that deserve our attention.

Congress has recently appropriated Fiscal Year 1989 funds for the National Science Foundation that include new funds within the Division of Mathematical Sciences to foster interactions with other areas of science and engineering. Over the past year, Division staff members have worked with the Advisory Committee for the Mathematical Sciences to determine how the Division might best take advantage of this situation. The committee has stressed the importance of fostering interactions that require participants to go well beyond their respective areas of expertise; nurturing young talent in the interdisciplinary mode of research; and involving underrepresented groups whenever possible.

The material below describes three areas in which we expect to use the new funds available to us in Fiscal Year 1989.

Computational Mathematics
Our first efforts in developing extended interactions can be found in the Computational Mathematics program as our component of the Foundation’s efforts in computational science and engineering. Many of the awards made under this program demonstrate how it is possible to involve mathematical scientists with others in science or engineering to develop activities that maximize the effectiveness of computational efforts. They involve new mathematics, new computational techniques, and cutting edge research in the areas of application. We intend to continue to expand this program, paying particular attention to areas involving algebraic and symbolic computation and visualization.

Biological Sciences
Perhaps the most exciting opportunity for enhanced interaction lies with the biosciences. This broad area of science has traditionally had limited interaction with the mathematical sciences. In building a structure that can support interactive work, we envision bringing new, previously untried and even unexpected mathematical tools into the frontiers of biological research. We expect to reach significantly into the core areas of mathematics (e.g., topology, operator algebras, probability, nonlinear dynamical systems, etc.) as well as involving the more traditional areas of applied mathematics and statistics.

Important components of this activity, in the long run, should include:
• a series of workshops exploring potential areas of interest to both mathematicians and biologists;
• training of new young investigators in both mathematical and biological methodologies;
• sabbatical support and career advancement awards for established investigators;
• undergraduate and graduate student participation;
• support for collaborative research projects; and
• strong computational and instrumentation development.

At this point in time, supporting such an extended program of interactions would strain our resources beyond what is feasible. However, we believe it is important to lay the groundwork now for enhanced collaboration in the future. We encourage you and your colleagues to think about how you might be able to participate in interactions with the biosciences. Proposals for workshops to explore potential areas of interest, for activities aimed at planning a collaborative research program, and for more fully developed collaborative research projects will be accepted and given every opportunity for funding by the several programs in the Division. We expect to continue working with appropriate units within NSF to develop a more formal arrangement for cooperative activity in the future.

Cosmology

Another area of current excitement, and somewhat closer to home in the sense of traditional applications of mathematics, is Cosmology. A recent joint subcommittee of the Advisory Committees for Mathematical Sciences, Astronomical Sciences and Physics has presented a report to the Foundation encouraging enhanced support for work in this area. We believe it is important for mathematicians and statisticians to be involved in this effort, and urge you to think about ways in which you or your colleagues might participate.

Proposals of the types listed above would be appropriate in this instance as well.

In all our efforts to enhance the collaborative aspects of our activity, we bear in mind the underlying principle that, if we are to share the fruit of mathematical knowledge, we must constantly keep developing that knowledge. This means ensuring that the base of mathematical inquiry is maintained and enlarged, and that our efforts at collaboration prove useful to both mathematics and our scientific partners. This is not an easy task, but we know we can count on the mathematical sciences community in maintaining the integrity of our efforts.

Sincerely,

Judith S. Sunley
Director,
Division of Mathematical Sciences

Open Letter on Group Funding

Dear Colleague:

This note is to update you on evolving opportunities for support of research and education in the mathematical sciences through the Division of Mathematical Sciences at the National Science Foundation. This year, in contrast to last, NSF has already received an appropriation for Fiscal Year 1989 (starting October 1, 1988) which allows our planning to proceed in a more orderly fashion. I would like to discuss our current plans for encouraging group-oriented activity within the framework of our standard research project support.

Rationale for Groups in the Mathematical Sciences. Mathematics thrives on the sharing of ideas among researchers. There has been a trend in recent years for significant work in the most active areas of the subject to emerge from groups of investigators organized around a common problem agenda or intellectual theme. The advantages of pooled insight and awareness make the successful research group more than the sum of its members. This is particularly important in research that requires input across the traditional subdisciplinary boundaries within the mathematical sciences or that cuts across major scientific disciplines.

Although individual efforts continue to be the core of the mathematics research enterprise, it is appropriate to recognize organized groups as a viable complement. Enhancing the effectiveness of these groups where they exist, and encouraging their formation where they are nascent, is part of the overall Division mission of fostering the mathematical sciences enterprise.

In addition, research groups provide opportunities for researchers who might otherwise remain isolated from the research enterprise. Geography, the nature of the institution in which a person works, or belonging to a group underrepresented in the mathematical sciences are all factors extraneous to mathematical ability or potential that can contribute to such isolation. Enhanced ability to provide for the involvement of undergraduate or graduate students, postdoctoral associates and visitors is another opportunity of group activity.

Plans for Fiscal Year 1989. Mathematical Sciences Research Groups will provide support for collaborative, multi-investigator research in all programs within the purview of the Division of Mathematical Sciences, across such programs, and jointly with other programs in the Foundation or at other Federal agencies. Group activity should envision work well beyond individually during a comparable time period.

Within each program, a small number of awards will be made that reflect the coalescing of research activity into this collaborative mode. The new funds available to us for this effort are limited, and we expect some realignment of existing funds (consonant with our inherent
emphasize on support of research by individual investigators).

Although the circumstances of any given situation may call for variations, two basic types of group activity are slated for enhanced support in Fiscal Year 1989 and beyond.

**Project Groups**: teams whose research effort is directed at a particular problem or class of problems.

**Program Groups**: strong groups working in a particular area of the mathematical sciences or an interdisciplinary area with a strong mathematical emphasis; should have a history of common seminars and collaborative research; awards would provide such things as support of visitors, postdoctoral researchers and students; inclusion of investigators from undergraduate institutions and underrepresented groups is encouraged.

Groups of the types indicated above, along with a number of activities where researchers with very loosely associated interests band together for administrative convenience, have long been a part of the range of activities supported by DMS. However, due to past scarcities in resources, researchers have hesitated to submit proposals whose primary focus is collaborative research, in the process depriving themselves of resources that might significantly enhance their ability to accomplish the research and limiting their effectiveness in training new investigators for the field.

During Fiscal Year 1989, the first year of our emphasis on group activity, we expect to place priority on the support of project groups. Past experience with group activity in the Computational Mathematics program suggests that such groups can enhance the visibility of research in the mathematical sciences and can stimulate new directions in research as well, making effective use of the resources provided and helping all of mathematics in the process.

The attached document [summarized in the following news item] provides more information about what we expect to find in proposals for Mathematical Sciences Research Groups. I hope you will give serious consideration to how you or members of your department might be able to benefit from and participate in this activity.

Sincerely,

Judith S. Sunley
Director,
Division of Mathematical Sciences

**Mathematical Sciences Research Groups**

In fiscal year 1989, the Division of Mathematical Sciences (DMS) at the NSF will launch a new program of Research Groups in the Mathematical Sciences. This program encompasses a range of activities that involve small groups of researchers working together toward common goals.

The program will provide support for collaborative, multi-investigator research in all programs within the purview of the DMS and in other programs in the NSF or at other federal agencies. Research Groups' proposals should envision work well beyond what could be accomplished by investigators working individually during a comparable time period.

Although the circumstances of any given situation may call for variations, two basic types of group activity are slated for enhanced support:

- **Project Groups**: teams whose research effort is directed at a particular problem or class of problems.
- **Program Groups**: strong groups that have a history of common seminars and collaborative research and that are working in a particular area of the mathematical sciences or an interdisciplinary area with a strong mathematical emphasis. Awards would provide for visitors, postdoctoral researchers, students, etc.

Inclusion of investigators from undergraduate institutions and underrepresented groups is encouraged.

Within these two categories, a number of formats are possible. For example, the groups need not be confined to a single department or institution. Considerable thought should be given to the role of undergraduate and graduate students, as well as postdoctoral associates and visitors. Generally, the groups will comprise a minimum of three investigators and will run 3-5 years.

Researchers whose principal source of external research support is outside the group are most likely to be interested in the program group; those contemplating organizing a group to attack a specific range of problems are most likely to be interested in the project group which would provide their principal source of research support.

In addition to following the usual NSF guidelines and proposal format instructions, Research Group proposals should document why funding through a group mechanism is appropriate to the research, what each investigator will contribute to the group, and how the group will influence the training of mathematical scientists and enhance their research capabilities. Proposals will be evaluated not only on the quality of the proposed research, but also on the importance of group collaboration in achieving the research objectives and evidence that the group is or will become more than the "sum of its parts."

Interested proposers should contact the most appropriate program director prior to proposal submission (see the DMS Staff List, Notices, September 1988, page 1008). Proposals should be clearly marked as submissions to the Research Groups' activity. It is strongly recommended that proposals for awards to begin during fiscal year 1989 be submitted to the NSF by December 15, 1988. For more information, contact: Division of Mathematical Sciences,
Finally, the salary ceiling is intended to apply to those subawards for substantive work under an NSF grant.

**Calculus Awards Announced**

The NSF has announced awards in its new program to revamp the calculus curriculum. The program, entitled Undergraduate Curriculum Development Program—Calculus, made 25 awards totalling $1.29 million. In addition, the grantee institutions are supplementing the NSF awards with an additional $.75 million.

The program awarded five multi-year grants, 19 one-year planning grants, and funds for a series of conferences. The AMS received one of the multi-year awards to begin a newsletter on collegiate mathematics education (for more information on the newsletter, see News and Announcements in this issue of Notices).

The purpose of the calculus reform program is to provide leadership to stimulate the development of high quality undergraduate mathematics curricula in this country. The projects are intended to develop effective teaching strategies, incorporate numerical/graphical computers and symbolic algebra systems, model realistic applied problems from the physical and social sciences, and conduct research in the teaching and learning of calculus.

The calculus program, begun this year, is part of the NSF's initiative in undergraduate science and engineering education. Another component of the initiative is a program for restructuring the undergraduate engineering curriculum. Both programs are part of the Office of Undergraduate Science, Engineering, and Mathematics Education, which was established in 1987 in the NSF's Directorate of Science and Engineering Education.

The calculus awards involve a broad segment of the mathematical sciences community: research institutions, two- and four-year colleges, high schools, and professional societies. The projects were selected on the basis of the excellence, innovation, and relevance of the curriculum; proposed cooperation with other disciplines; and potential for long-range, national impact. Many of the projects were jointly funded by the calculus program and by the Division of Mathematical Sciences, the Division of Computer and Computation Research, and other divisions within the NSF's education directorate.

The titles, institutions, and principal investigators for the multi-year grants are listed below, together with brief descriptions of the projects.

- **Calculus in context**, James Callahan, Smith College. Sponsored by Five Colleges, Inc. (Amherst, Hampshire, Mount Holyoke, and Smith Colleges, and the University of Massachusetts). To design a three-semester calculus curriculum based on the mathematical themes of optimization, estimation/approximation, differential equations, and functions of several variables.

- **Student research projects in the calculus curriculum**, Marcus S. Cohen, New Mexico State University. To develop a course in which traditional examinations are replaced by individual research projects that explore the mathematical underpinnings of solutions to applied problems.

- **The design of a computer algebra system to effect a more relevant mathematics curriculum**, J. Douglas Child, Rollins College. To experiment with a computer environment consisting of a computer algebra system, MAPLE, and a specially designed interface to MAPLE that is more suitable for teaching and learning calculus for the average student.

- **An integrated program in calculus and physics**, Richard Yeatts, Colorado School of Mines. To develop and team teach an integrated calculus and physics course reinforced by combined physics laboratory and mathematics workshop sessions.
- Newsletter on collegiate mathematics education, James A. Voytuk, American Mathematical Society. To establish a collegiate mathematics education newsletter in cooperation with the Mathematical Association of America and the Society for Industrial and Applied Mathematics in order to stimulate greater communication between the various communities involved in mathematics education at the collegiate level.

In addition, the following one-year awards were made:

- Calculus workshops and conferences, Shair Ahmad, University of Miami.
- Calculus planning project, Nagambal Shah, Spelman College.
- Calculus curriculum development, Gerald Janusz, University of Illinois, Urbana-Champaign.
- Calculus, concepts, and computers, Ed Dubinsky, Purdue University.
- Planning for a revitalization of an engineering/physical science calculus, Elgin H. Johnston, Iowa State University.
- Dynamic calculus, Robert L. Devaney, Boston University.
- The language of change: A project to rejuvenate calculus and instruction, Andrew M. Gleason, Harvard University.
- Calculus reform in liberal arts colleges, A. Wayne Roberts, Macalester College.
- Development of calculus, Lawrence C. Moore, Jr, Duke University.
- From Euclid to von Neumann, an activity-based learning experience in calculus: Project ENABLE, Joan Ferrini-Mundy, University of New Hampshire.
- Planning a problem-based calculus curriculum, Stephen R. Hilbert, Ithaca College.
- Toward a conceptual and captivating calculus, Thomas A. Farmer, Miami University, Oxford Campus.
- Plan for calculators in the calculus curriculum, Thomas Dick, Oregon State University.
- Integrated calculus development, Alain Schremmer, Community College of Philadelphia.
- Revitalization of calculus, Mary McCammon, Pennsylvania State University, University Park.
- The calculus companion: A computerized tutor and computational aid, Edmund A. Lamagna, University of Rhode Island.
- Restructuring one variable calculus within a modeling and computer-oriented environment, Daniel C. Sloughter, Furman University.
- Development of computer-based curriculum materials for calculus: A planning project, Michael E. Moody, Washington State University.

In fiscal year 1989, the Undergraduate Curriculum Development Program—Calculus will be much the same as in 1988, but new planning grants have been essentially eliminated. The closing date for curriculum development proposals is February 1, 1989. Proposals for conferences and workshops may be submitted at any time and require about 6 months processing time.

The new program director for calculus curriculum development is John Kenelly of Clemson University. Kenelly replaces Louise Raphael, who has returned to Howard University. He can be reached at the National Science Foundation, Room 639, 1800 G Street, NW, Washington, DC 20550; telephone 202-357-7051; electronic addresses jkenelly@nsf (for BITNET), and jkenelly@note.nsf.gov (for Internet).

Undergraduate Instrumentation Awards

The NSF has made 362 awards totaling more than $11 million in its undergraduate Instrumentation and Laboratory Improvement program. These awards were made to doctoral institutions offering degree programs in one or more of the NSF-supported fields of science, engineering, and mathematics. This year was the first time two-year and community colleges were included in the program.

Because each award is matched dollar-for-dollar by the institution, about $12 million will be contributed from local sources toward support of instructional modernization at these 261 undergraduate institutions. This means of support often establishes lasting partnerships between colleges and private industry.

In addition to fostering the development of curricula and laboratories, this program is designed to benefit undergraduate student research programs, projects for non-science majors, and projects that improve the training of precollege teachers of science and mathematics.

There were several awards made in the mathematical sciences and in computer science. The names of the principal investigators and their institutions are: BETTY L. ACORD, Connors State College; KASI ANANTHANARYAN, San Diego State University; WILLIAM C. BAUDRY, Appalachian State University; Denny Burzynski, West Valley College; Jean B. Chan, Sonoma State University; RUPH CHASSAING, Roger Williams College; J. DOUGLAS CHILD, Rollins College; ROBERT S. CUNNINGHAM, California State College, Stanislaus; GLORIA L. DRAPAC, Mount Mercy College; LESLIE V. FOSTER, San Jose State University; JAMES FREEMAN, Cornell College; ROBERT GEITZ, Oberlin College; DWIGHT GOODE, Texas A & I University; DANIEL C. HYDE, Bucknell University; DAVID W. KAMMER, Albion College; KARL W. KNIGHT, Gustavus Adolphus College; JOEL P. LEHMANN, Valparaiso University; MARILYN L. LIVINGSTON, Southern Illinois University, Edwardsville; ROBERT J. LOPEZ, Rose-Hulman Institute of Technology; ALAN MAGNUSON, St. Olaf College; CHRISTINE
E. McGahe, Moorhead State University; Larry Menninga, Western Washington University; Thomas J. Myers, Colgate University; Thomas L. NAPS, Lawrence University; Stanley D. Nel, University of San Francisco; Edward G. Pekarek, Appalachian State University; Hayden S. Porter, Jr., Furman University; August E. Saepa, Trinity College; Alice A. Sayler, Bloomsfield College; G. Michael Schneider, Macalester College; Stillman E. Sims, St. Mary’s University; John C. Slimick, University of Pittsburgh, Bradford; Raymond Smith, Whittier College; P. K. Subramanian, California State University, Los Angeles; Hugh D. Sullivan, Eastern Washington University; Patricia A. Wenner, Bucknell University; Gareth Williams, Stetson University.

NSB Confirmation and Appointments

The Senate has confirmed three appointments to the National Science Board (NSB), the policy-making body of the NSF. In addition, President Reagan has announced one reappointment and two new appointments to the Board. All of the appointments last until 1994.

The three who have been confirmed are Warren J. Baker, President of California Polytechnic Institute (reappointment); Daniel C. Drucker, Graduate Research Professor, Department of Aerospace Engineering, Mechanics, and Engineering Science, University of Florida at Gainesville; and Charles Hosler, Senior Vice President for Research and Dean of the Graduate School, Pennsylvania State University.

Roland W. Schmitt, President of Rensselaer Polytechnic Institute and former NSB chairman, has been reappointed to the Board. The new appointments are D. Allan Bromley, Director, Nuclear Structure Laboratory, Yale University; and Arden L. Bement, Jr., Vice President of TRW Incorporated. Two more appointments are to be made.

Drucker succeeds NSB member William F. Miller, a computer scientist and President and Chief Executive Officer of SRI International. Miller was the only Board member belonging to a major professional organization in the mathematical sciences. The 24-member Board has had no representative from mathematics since 1986.

New Director in Advanced Scientific Computing

Tom Weber, Program Director for Computational Chemistry at the NSF, has been appointed Director of the NSF’s Division of Advanced Scientific Computing. Prior to coming to the NSF about a year and a half ago, Weber was at Bell Laboratories. He has extensive experience in supercomputing. For the past year, Melvyn Ciment has been Acting Division Director and now resumes his post as Deputy Division Director. Before he took that position in 1987, Ciment was Program Director for Computational Mathematics in the Division of Mathematical Sciences.

THÉORIE DES VARIÉTÉS MINIMALES ET APPLICATIONS (MINIMAL SUBMANIFOLDS) SÉMINAIRE PALAISEAU
(Astérisque, Number 154-155)

The study of minimal submanifolds is by now established as one of the deep and aesthetically appealing parts of mathematics. It combines in an exemplary fashion geometric and analytical techniques both of a classical and of a more modern nature. In recent years it became a powerful tool to investigate the internal geometry of manifolds, a subject of interest today to both mathematicians and theoretical physicists.

This volume, devoted to notes of a seminar held from October 1983 to June 1984 under the direction of H. B. Lawson Jr. at Ecole Polytechnique in Palaiseau, presents recent contributions to the theory of minimal submanifolds in their diversity. It starts with an elementary approach to the subject, hence is appropriate as a source book for a graduate seminar.

SOCIÉTÉ MATHÉMATIQUE DE FRANCE, ASTÉRISQUE

The AMS distributes Astérisque only in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF, B.P. 126-05, 75228 Paris Cedex 05, France, or to OFFLIB, 48 rue Gay-Lussac, 75240 Paris Cedex 05, France. Individual members of either AMS or SMF are entitled to the member price. (ISSN 0303-1179)
News from Washington

NRC Research Associateships

The National Research Council (NRC) announces the 1989 Resident, Cooperative, and Postdoctoral Research Associateship Programs for research in the sciences and engineering to be conducted on behalf of 30 federal agencies or research institutions, whose 115 participating research laboratories are located throughout the United States. The programs provide opportunities for Ph.D. scientists and engineers of unusual promise and ability to perform research on problems largely of their own choosing yet compatible with the research interests of the supporting laboratory. Initiated in 1954, the Associateship Programs have contributed to the career development of over 5500 scientists ranging from recent Ph.D. recipients to distinguished senior scientists.

Approximately 450 new full-time Associateships will be awarded on a competitive basis, in 1989, for research in: chemistry, earth and atmospheric sciences; engineering and applied sciences; biological, health, behavioral sciences and biotechnology; mathematics; space and planetary sciences; and physics. Most of the programs are open to both U.S. and non-U.S. nationals and to both recent Ph.D. degree recipients and senior investigators.

Awards are made for one or two years, renewable to a maximum of three years; senior applicants who have held the doctorate at least five years may request shorter tenure. Annual stipends for recent Ph.D.s for the 1989 program year will vary from $27,150 to $35,000, depending upon the sponsoring laboratory, and will be appropriately higher for senior associates.

Reimbursement is provided for allowable relocation costs and for limited professional travel during tenure. The host laboratory provides the Associate with programmatic assistance including facilities, support services, necessary equipment, and travel necessary for the conduct of the approved research program.

Applications to the NRC must be postmarked no later than January 15, 1989, (December 15 for NASA), April 15 and August 15, 1989. Initial awards will be announced in March and April (July and November for the two later competitions) followed by awards to alternates later.

Information on specific research opportunities and federal laboratories, as well as application materials, may be obtained from the Associateship programs (GR430A-D3), Office of Scientific and Engineering Personnel, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418; telephone (202) 334-2760.

New Prize at Engineering Academy

The National Academy of Engineering (NAE) has announced the establishment of a major new award for achievement in engineering and technology. Endowed by the Charles Stark Draper Laboratory of Cambridge, Massachusetts, the prize consists of a gold medal and $350,000 in prize money.

The Draper Prize recognizes engineering and technology achievements "contributing to the advancement of human welfare and freedom." The first prize recipient will be announced in October 1989, and awards will be made biennially after that.

The prize may be given to any living individual or group of individuals from any country for either a specific engineering/technology achievement or for a body of work extending over a period of years. Work within all engineering disciplines will be eligible.

Nominations will be solicited from a broad range of U.S. and international scientific and engineering societies and other individuals deemed eligible by the NAE. The award recipient will be selected by a committee appointed by the NAE and chaired by Robert C. Seamans, Jr., senior lecturer in the department of aeronautics and astronautics, Massachusetts Institute of Technology.

Charles Stark Draper developed the theory and invented and developed the technology of inertial guidance systems now universally used in aircraft, submarines, missiles, and space vehicles.
Scientific Exchanges with the U.S.S.R. and Eastern Europe

The National Academy of Sciences (NAS) invites applications from American Scientists who wish to make visits during the period January 1, 1990, through December 31, 1990, to the U.S.S.R., Bulgaria, Czechoslovakia, the German Democratic Republic, Hungary, Poland, Romania, and Yugoslavia. Long-term research visits of 3 to 12 months duration are encouraged, particularly if contact with colleagues in the other country has already been established. The minimum length of visits is one month in one country.

Applicants must be U.S. citizens and have a doctoral degree or its equivalent by June 1989, in physics; chemistry; mathematics and computer sciences; earth, atmospheric, and oceanographic sciences; agricultural, forestry, fishery, and plant sciences; biological sciences; environmental sciences; engineering; archaeology and anthropology; geography; or psychology. Also included are science and technology policy and those aspects of the economic and social sciences that involve quantitative analysis as a primary consideration. Other scientific disciplines not explicitly mentioned will be considered on a case-by-case basis. Necessary expenses will be met by the NAS and the foreign academy, including reimbursement for long-term visitors for salary lost up to a predetermined maximum and expenses for accompanying family members for visits exceeding five months.

Requests for applications should reach the National Academy of Sciences not later than February 14, 1989. Applications must be postmarked by February 28, 1989. Address application requests to:
National Academy of Sciences
Office of International Affairs
Soviet and East European Affairs (HA-166)
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
Telephone: (202) 334-2644

Joint Mathematics Meetings

January 11-14, 1989
Phoenix, Arizona
The AMS Centennial was the event of the century for the American mathematical community. Whether you were there or not, mementos of this very special occasion will serve as reminders of the history and achievements of the last 100 years of American mathematics.

**CENTENNIAL GROUP PHOTO**

This photo was taken on the steps of the Rhode Island State House, a historical landmark itself and the site of the gala Opening Reception of the Centennial. The photo, which shows over 1,000 Centennial participants, is in full color with a dull gloss finish. It measures 16x20 inches, with an image area of 8x20 inches.

$25 (includes shipping & handling)
Allow 6 weeks for delivery
Order Code: CENTPIC/NA

**SEMICENTENNIAL PICTURE**

This delightful piece of memorabilia shows the group of almost 450 people who attended the Semicentennial in 1938. Taken in front of the Low Library of Columbia University, the Society's home at that time, the photo shows such legendary mathematicians as Norbert Weiner, G. D. Birkhoff, J. W. Tukey, Eric Temple Bell, E. J. McShane, A. W. Tucker, Hassler Whitney...the list goes on. The matte finish photo measures 16x20 inches and carries the names of all the individuals photographed. It's a snapshot in time of the American mathematical community of 50 years ago.

$20 (includes shipping and handling)
Allow 6 weeks for delivery
Order Code: SEMIPIC/NA

**CENTENNIAL PROGRAM**

The Centennial program will serve as a reminder of all the exciting mathematical and social events during the meeting. The bright red cover is embossed with a shiny gold medallion showing a copy of a portrait study of the Society's founder, Thomas Scott Fiske. The same portrait adorned the cover of the program at the Semicentennial banquet in 1938. The program contains an article providing a perspective on the growth of the AMS, written by Everett Pitcher.

$5 (includes shipping and handling)
Order Code: CENTPROG/NA

**CENTENNIAL TILES**

These tiles display the original "Call to Mathematicians" issued by the Society's founder and his two friends on Thanksgiving Day in 1888. Made of ceramic with a cork backing, the tiles, which can be used as coasters, are attractively decorated in the Centennial colors of red on beige. The tiles measure 4 1/2 inches square.

$5 (includes shipping & handling)
Order Code: TILES/NA

**TO ORDER:** Prepayment required in U.S. funds. Mail to: American Mathematical Society, Annex Station, P.O. Box 1571, Providence, Rhode Island, 02901-1571 USA or call 800-556-7774 in the continental U.S. to use VISA or MasterCard.
Meetings and Conferences of the AMS

FUTURE MEETINGS

Phoenix, January 11-14 1369
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FUTURE CONFERENCES

Summer Seminar in Applied Mathematics
Virginia Polytechnic Institute and State University, May 29–June 9 1374
Joint Summer Research Conferences in the Mathematical Sciences
Humboldt State University, June 3–August 5 1375
Summer Research Institute
University of California, Santa Cruz, July 10–30 1379
Coming Events

Be sure to see the new information included in this issue on the January 11-14, 1989 meetings in Phoenix, Arizona. Don’t forget that the preregistration deadline is November 10!

Information on various summer conferences scheduled for 1989 is included in this issue. These programs have proved quite popular over the years, and we are pleased to continue a tradition of excellence with the topics for next year:

The 1989 AMS Summer Research Institute on *Several Complex Variables and Complex Geometry* will be held at the University of California, Santa Cruz, July 10-30.

The 1989 AMS-SIAM Summer Seminar in Applied Mathematics on *Mathematics of Random Media* will be held at Virginia Polytechnic Institute and State University, Blacksburg, Virginia, May 29–June 9.

There will be eight Joint Summer Research Conferences in the Mathematical Sciences on various topics. These will be held at Humboldt State University, Arcata, California, June 3 to August 5.

The August 7-10, 1989 meeting in Boulder, Colorado will witness the debut of a new lecture series, *Progress in Mathematics*, which will become a permanent addition to the summer program. See future issues for details.
Supplement to Announcement in October Notices

Please refer to the Preliminary Announcement for this meeting which appears on pages 1191-1235 of the October 1988 issue of Notices. The Table of Contents and Important Deadlines for the preliminary announcement are reproduced below for convenience.

Gibbs Lecture

The title of the Gibbs Lecture to be given by ELLIOTT H. LIEB on Wednesday, January 11, is *The stability of matter: From atoms to stars.*

AMS-MAA Invited Addresses

CATHLEEN S. MORAWETZ'S last name was incorrectly given in the first announcement. We apologize for this error. In addition, her title has changed to *Transonic flow and mixed equations.*

The title of the Invited Address to be given by STEPHEN SMALE is *Story of the higher dimensional Poincaré conjecture (What actually happened on the beaches of Rio de Janeiro).*

AMS Invited Addresses

The title of the Invited Address to be given by LENORE BLUM is *Computing over the reals (or any arbitrary ring).*

The title of the Invited Address to be given by PERCY ALEC DEIFT is *Matrix factorizations and the KdV method.*

The title of the Invited Address to be given by PETER S. LANDWEBER is *Elliptic genera and elliptic cohomology.*

The title of the Invited Address to be given by DIANA FROST SHELSTAD is *Transfer of representations.*

### IMPORTANT DEADLINES

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Meetings

The title of the Invited Address to be given by Luc Tartar is $H$-measures, a new tool for studying homogenization, concentration and partial differential equations.

AMS Short Course

Short Course Lecture #4 by Arunava Mukherjee will end at 4:45 p.m. not 4:30 p.m.

AMS Special Session

The title of the special session being organized by Percy Alec Deift has been changed to $KdV$ as a tool in mathematics.

The correct name of one of the organizers of the special session on Geometry of hyperbolic dynamical systems is Joseph Christy.

Other MAA Sessions

Panelists for the Panel Discussion on Calculus initiatives—an update scheduled for Saturday, January 14, include James J. Callahan, Smith College; Thomas P. Dick, Oregon State University; Douglas S. Kurtz, New Mexico State University at Las Cruces; and Sherman K. Stein, University of California at Davis.

Panelists for the Panel Discussion on How to break into print in mathematics scheduled for Wednesday, January 11, include Donald J. Albers, Menlo College; Linda W. Brinn, University of Michigan, Dearborn; Joan P. Hutchinson, Smith College; and Doris W. Schattschneider, Moravian College.

Speakers for the session on Teaching mathematical modeling scheduled for Saturday, January 14, include Michael Olinik, Middlebury College; Ernest Manfred, U.S. Coast Guard Academy; Joseph Malkevitch, York College; F. R. Giordano, U.S. Military Academy and M.D. Wier, Naval Postgraduate School; Richard Bronson, Fairleigh Dickinson University; and Jeanne Agnew and John Jobe, Oklahoma State University.

Activities of Other Organizations

The Joint Policy Board for Mathematics Committee for Mathematics Department Heads on Outside funding for the undergraduate curriculum on Friday, January 13, is being organized by David J. Lutzer, College of William and Mary. The first session at 7:00 p.m. will include talks by Kent Wilson, Executive Officer, Directorate for Mathematical and Physical Sciences, National Science Foundation; and John Kenelly, Program Director, Division of Undergraduate Science, Engineering and Mathematics Education, National Science Foundation.

This will be followed at 8:00 p.m. by three Birds-of-a-feather sessions as follows:

Examples of outside funding for undergraduate mathematics, Robert Borelli, Harvey Mudd College;

Academic employment of master's level mathematicians, Donald Reynolds, Indiana State University; and

Update on the second David Report, Lawrence Cox, National Academy of Sciences/Board on Mathematical Sciences.

The Rocky Mountain Mathematics Consortium's Board of Directors' Meeting has been moved to Friday, January 13, from 2:15 p.m. to 4:05 p.m.

Employment Register

The telephone number to be used for the Employment Register after it begins in Phoenix is 602-239-7904. Please note that this number will be for those who will be participating in the Employment Register and is not for contacting participants or taking messages.

Lance W. Small
Associate Secretary
La Jolla, California
## Invited Speakers and Special Sessions

### Invited Speakers at AMS Meetings

The individuals listed below have accepted invitations to address the Society at the times and places indicated. For some meetings, the list of speakers is incomplete.

#### Phoenix, January 1989
- Lenore Blum
- Ralph P. Boas (AMS-MAA)
- John H. Conway
- Percy Alec Deift
- David Fried
- Ronald L. Graham (AMS-MAA)
- Peter Landweber
- Cathleen S. Morawetz (AMS-MAA)
- Diana Frost Shelstad
- Stephen Smale (AMS-MAA)
- Luc Tartar

#### Worcester, April 1989
- Igor Frankel
- Thomas H. Parker
- Henri Gillet
- Nicholas Lerner
- Haim Brezis (Progress in Mathematics Lecture)
- Richard Herman
- Adrian Ocneanu
- Karl Rubin
- Richard Rochberg
- Shmuel Weinberger

#### Chicago, May 1989
- William Gillet
- Nicholas Lerner
- Haim Brezis (Progress in Mathematics Lecture)
- Richard Herman
- Adrian Ocneanu

#### Boulder, August 1989
- Russell Caflisch
- Fang Hua Lin
- Kenneth Meyer
- Steven Muhly

### Organizers and Topics of Special Sessions

The list below contains all the information about Special Sessions at meetings of the Society available at the time this issue of *Notices* went to the printer. The section below entitled Information for Organizers describes the timetable for announcing the existence of Special Sessions.

### January 1989 Meeting in Phoenix

- **Associate Secretary:** Lance W. Small
- **Deadline for organizers:** Expired
- **Deadline for consideration:** Expired
- Melvyn S. Berger, *Mathematics of nonlinear science*
- Lenore Blum, *Foundations of complexity theory for numerical analysis*
- John H. Conway, Harry Gonshor, and Martin Kruskal, *Surreal numbers*
- Percy Alec Deift, *KdV as a tool in mathematics*
- David Eisenbud and Craig Huneke, *Commutative algebra and algebraic geometry*
- David Fried and Joseph Christy, *Geometry of hyperbolic dynamical systems*
- Larry C. Grove and M. F. Newman, *Computational group theory*
- William A. Harris, *Singular perturbation theory*
- Victor J. Katz and Florence Fasanelli, *History of mathematics*
- Albert Marden and Burton Rodin, *Computational aspects of complex analysis*
- Sidney Port, *Stochastic processes*
- Marc A. Rieffel, *Operator algebras and geometry*
- Hal L. Smith and James Cushing, *Mathematics in population biology*

### April 1989 Meeting in Worcester

- **Associate Secretary:** W. Wistar Comfort
- **Deadline for organizers:** Expired
- **Deadline for consideration:** January 4, 1989
- Richard Herman and Adrian Ocneanu, *Operator algebras, Galois theory and representations*
- James Lepowsky, *Infinite-dimensional symmetries in mathematics and physics*
- Thomas H. Parker, *Gauge theory and differential geometry*
- Karl Rubin and Glenn Stevens, *L-functions and arithmetic*
- Lee Rudolph, *Knot theory and algebraic geometry in the large*
### Invited Speakers and Special Sessions

**May 1989 Meeting in Chicago**  
Central Section  
Associate Secretary: Andy Roy Magid  
Deadline for organizers: November 15, 1988  
Deadline for consideration: April 25, 1989

Jeffery Bergen, *Noncommutative ring theory*  
Martin Butinas and Billy Rhoades, *Sequence spaces and summability*  
Tim D. Cochran, *Geometric topology*  
Jonathan Cohen, *Numerical methods in harmonic analysis*  
Vinay Deodhar, *Kazhdan-Lusztig theory and related topics*  
Stephen Doty, *Algebraic groups and related topics*  
Henri Gillett, *Arithmetic geometry and intersection theory*  
Christine Haught, *Recursion theory*  
Cary Huffman and Neal Brand, *Codes and designs*  
Ronnie Lee and Steven Weintraub, *Algebraic topology of varieties*  
Nicholas Lerner, *Partial differential equations*  
Colm Mulcahy and Victoria Powers, *Quadratic forms and real algebraic geometry*  
S. P. Singh, *Nonlinear analysis and its applications*

**August 1989 Meeting in Boulder**  
Associate Secretary: Andy Roy Magid  
Deadline for consideration: July 26, 1989

**October 1989 Meeting in Hoboken**  
Eastern Section  
Associate Secretary: W. Wistar Comfort  
Deadline for consideration: July 26, 1989†

**October 1989 Meeting in Muncie**  
Central Section  
Associate Secretary: Andy Roy Magid  
Deadline for consideration: July 26, 1989†

†Please note a change in this deadline making it earlier than the deadline previously published.

### Information for Organizers

Special Sessions at Annual and Summer Meetings are held under the supervision of the Program Committee for National Meetings. They are administered by the Associate Secretary in charge of that meeting with staff assistance from the Meetings and Editorial Departments in the Society office in Providence.

According to the “Rules for Special Sessions” of the Society, Special Sessions are selected by the Program Committee from a list of proposed Special Sessions in essentially the same manner as Invited Speakers are selected. The number of Special Sessions at a Summer or Annual Meeting is limited. The algorithm that determines the number of Special Sessions allowed at a given meeting, while simple, is not repeated here, but may be found in “Rules for Special Sessions” which can be found on page 614 in the April 1988 issue of Notices.

Each Invited Speaker is invited to generate a Special Session, either by personally organizing one or by having a Special Session organized by others. Proposals to organize a Special Session are sometimes requested either by the Program Committee or by the Associate Secretary. Other proposals to organize a Special Session may be submitted to the Associate Secretary in charge of that meeting (who is an ex-officio member of the committee and whose address may be found below). These proposals must be in the hands of the Program Committee well in advance of the meeting and, in any case, at least nine (9) months prior to the meeting at which the Special Session is to be held in order that the committee may consider all the proposals for Special Sessions simultaneously. Proposals that are sent to the Providence office of the Society, to Notices, or directed to anyone other than the Associate Secretary will have to be forwarded and may not be received in time to be considered for acceptance.

It should be noticed that Special Sessions must be announced in Notices in such a timely fashion that any member of the Society who so wishes may submit an abstract for consideration for presentation in the Special Session before the deadline for such consideration. This deadline is usually three (3) weeks before the Deadline for Abstracts for the meeting in question.

Special Sessions are very effective at Sectional Meetings and can usually be accommodated. They are selected by the Committee to Select Hour Speakers for the Section. The processing of proposals for Special Sessions for Sectional Meetings is handled by the Associate Secretary for the Section, who then forwards the proposals to the Committee to Select which makes the final selection of the proposals. Each Invited Speaker at a Sectional Meeting is invited to organize a Special Session. Just as for national meetings, no Special Session at a Sectional Meeting may be approved so late that its announcement appears past the deadline after which members can no longer send abstracts for consideration for presentation in that Special Session.

The Society reserves the right of first refusal for the publication of proceedings of any Special Session. These proceedings appear in the book series *Contemporary Mathematics*.

More precise details concerning proposals for and organizing of Special Sessions may be found in the “Rules for Special Sessions” or may be obtained from any Associate Secretary.
Send Proposals for Special Sessions to the Associate Secretaries

The programs of sectional meetings are arranged by the Associate Secretary for the section in question:

Far Western Section (Pacific and Mountain)
Lance W. Small, Associate Secretary
Department of Mathematics
University of California, San Diego
La Jolla, CA 92093
(Telephone 619–534–3590)

Central Section
Andy Roy Magid, Associate Secretary
Department of Mathematics
University of Oklahoma
601 Elm PHSC 423
Norman, OK 73019
(Telephone 405–325–2052)

Eastern Section
W. Wistar Comfort, Associate Secretary
Department of Mathematics
Wesleyan University
Middletown, CT 06457
(Telephone 203–347–9411)

Southeastern Section
Frank T. Birtel, Associate Secretary
Department of Mathematics
Tulane University
New Orleans, LA 70118
(Telephone 504–865–5646)

As a general rule, members who anticipate organizing Special Sessions at AMS meetings are advised to seek approval at least nine months prior to the scheduled date of the meeting. No Special Sessions can be approved too late to provide adequate advance notice to members who wish to participate.

Information for Speakers

A great many of the papers presented in Special Sessions at meetings of the Society are invited papers, but any member of the Society who wishes to do so may submit an abstract for consideration for presentation in a Special Session, provided it is received in Providence prior to the special early deadline announced above and in the announcements of the meeting at which the Special Session has been scheduled. Contributors should know that there is a limitation in size of a single special session, so that it is sometimes true that all places are filled by invitation. Papers not accepted for a Special Session are considered as ten-minute contributed papers.

Abstracts of papers submitted for consideration for presentation at a Special Session must be received by the Providence office (Editorial Department, American Mathematical Society, P. O. Box 6248, Providence, RI 02940) by the special deadline for Special Sessions, which is usually three weeks earlier than the deadline for contributed papers for the same meeting. The Council has decreed that no paper, whether invited or contributed, may be listed in the program of a meeting of the Society unless an abstract of the paper has been received in Providence prior to the deadline.

Send Proposals for Special Sessions to

John Brillhart, D. H. Lehmer, J. L. Selfridge
Bryant Tuckerman, and S. S. Wagstaff, Jr.

(Contemporary Mathematics, Volume 22, Second Edition)

This book is a revised and updated edition of a work that originally appeared in 1983. It gives a historical account of the various methods and machines that have been used to factor, and prove prime, the numbers $b^n \pm 1$. It is a revised version of an extension of a rare 1925 work by Cunningham and brings together results going back to the seventeenth century. The factorizations and the very large primes of special form are useful in group theory, number theory, discrete Fourier transforms, random number generators, and cryptography. The present edition contains more than 2000 large primes which have never been published before.

The book contains complete factorizations of $b^n \pm 1$ for the given values of $b$ and for all $n \leq 100$, and for many $n > 100$. Included is an extensive and valuable introduction which describes the developments in computing technology and in methods of factoring and primality testing which have occurred since 1925. An update to the introduction is included in this edition and discusses the major advances that have been made in the five years since the first edition appeared. The introduction also discusses the multiplicative structure of $b^n \pm 1$ and explains the relation between the two kinds of algebraic factorizations of these numbers.

1980 Mathematics Subject Classification: 11
ISBN 0-8218-5078-4, LC 83-12316
ISSN 0271-4132
320 pages (softcover), June 1988
Individual member $19, List price $31,
Institutional member $25
To order, please specify CONM/22 NA

Shipping/Handling: 1st book $2, each add’l $1, $25 max. By air, 1st book $5, each add’l $3, $100 max.
Prepayment required. Order from AMS, P.O. Box 1571,
Annex Station, Providence, RI 02901-1571, or call 800-556-7774 to use VISA or MasterCard.
The twentieth AMS-SIAM Summer Seminar in Applied Mathematics will be held May 29–June 9, 1989, at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. The seminar will be sponsored jointly by the American Mathematical Society and the Society for Industrial and Applied Mathematics. It is anticipated that the seminar will be supported by a grant from federal agencies. The proceedings of the seminar will be published by the Society in the *Lectures in Applied Mathematics* series.

Speakers will present recent results from stochastic process, theory and applications with special emphasis on: effective medium theory, interacting particle systems, diffusions and wave propagation in random media. In addition, survey lectures will be provided to orient nonspecialists in these fields.

The Organizing Committee consists of MARTIN DAY, Virginia Polytechnic Institute and State University; RICHARD DURRETT, Cornell University; WERNER KOHLER, Virginia Polytechnic Institute and State University, co-chairman; GRAEME MILTON, Courant Institute of Mathematical Sciences, New York University; and BENJAMIN WHITE, Exxon Research & Engineering Company, co-chairman.

The tentative list of invited speakers include: ROBERT BURRIDGE, Schlumberger Doll Research Center; MARK FREIDLIN, University of Maryland; JOSEPH KELLER, Stanford University; HARRY KESTEN, Cornell University; THOMAS KURTZ, University of Wisconsin; THOMAS LIGGETT, University of California, Los Angeles; CHARLES NEWMAN, University of Arizona; GEORGE PAPANICOLAOU, Courant Institute of Mathematical Sciences, New York University; THOMAS SPENCER, Institute for Advanced Studies; LUC TARTAR, Carnegie Mellon University; S.R.S. VARADHAN, Courant Institute of Mathematical Sciences, New York University.

A brochure will be available from the AMS office which will include a description of the scientific program, information on accommodations, and local information. Participants will be required to pay a nominal registration and social fee.

Those interested in attending the seminar should send the following information to Betty A. Verducci, Summer Seminar Conference Coordinator, American Mathematical Society, P. O. Box 6248, Providence, RI 02940, E-Mail: BAV@Seed.AMS.Com. **before March 1, 1989.**

Please type or print the following:
1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Anticipated arrival and departure dates;
5. Your scientific background relevant to the topic of the seminar;
6. Financial assistance requested (please estimate cost of travel);
7. Indicate if support is not required, and if interested in attending even if support is not offered.

Participants who wish to apply for a grant-in-aid should so indicate; however, funds available for the seminar are very limited and individuals who can obtain support from other sources should do so.

Graduate students who have completed at least one year of graduate school are encouraged to participate.
The 1989 Joint Summer Research Conferences in the Mathematical Sciences will be held at Humboldt State University, Arcata, California, from June 3 to August 5. It is anticipated that the series of conferences will be supported by grants from the National Science Foundation and other agencies.

There will be eight conferences in eight different areas of mathematics. The topics and organizers for the conferences were selected by the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The selections were based on suggestions made by the members of the committee and individuals submitting proposals. The committee considered it important that the conferences represent diverse areas of mathematical activity, with emphasis on areas currently especially active, and paid careful attention to subjects in which there is important interdisciplinary activity at present.

The conferences are similar in scientific structure to those held throughout the year at Oberwolfach. These conferences are intended to complement the Society's program of annual Summer Institutes and Summer Seminars, which have a larger attendance and are substantially broader in scope. The conferences are research conferences, and are not intended to provide an entree to a field in which a participant has not already worked.

It is expected that funding will be available for a limited number of participants in each conference. Others, in addition to those funded, will be welcome, within the limitations of the facilities of the campus. In the spring a brochure will be mailed to all who are invited to attend the conferences. The brochure will include information on room and board rates, the residence and dining hall facilities, travel and local information and a Residence Housing Form to use for on-campus housing accommodations. Information on off-campus housing will also be included in the brochure. Participants are required to make their own housing and travel arrangements. Each participant will be required to pay a nominal registration and social fee.

Those interested in attending one of the conferences should send the following information to Carole Kohanski, Summer Research Conference Coordinator, American Mathematical Society, P.O. Box 6248, Providence, RI 02940, E-Mail: CAK@MATH.AMS.COM.

Please type or print the following:
1. Title and dates of conference desired;
2. Full name;
3. Mailing address;
4. Telephone number and area code for office and home;
5. Your scientific background relevant to the topic of the conference;
6. Financial assistance requested; please estimate cost of travel;
7. Indicate if support is not required, and if interested in attending even if support is not offered.

The deadline for receipt of applications is February 24, 1989. Requests for invitations will be forwarded to the Organizing Committee for each conference for consideration. Requests will be considered after February 24, 1989, and applicants selected will receive formal invitations and notification of financial assistance from the AMS. Requests received past the deadline will be returned. Funds available for these conferences are limited and individuals who can obtain support from other sources should do so. Women and members of minority groups are encouraged to apply and participate in these conferences.

Any questions concerning the scientific portion of the conference should be directed to the chair or any member of the Organizing Committee.

The Joint Summer Research Conferences in the Mathematical Sciences are under the direction of the AMS-IMS-SIAM Committee on Joint Summer Research Conferences in the Mathematical Sciences. The following Committee members chose the topics for the 1989 conferences: William B. Arveson, John A. Burns, Martin Golubitsky, Daniel J. Kleitman, James I. Lepowsky, Ingram Olkin, Mary Ellen Rudin, Lesley M. Sibner, and Stephen Simpson.
Saturday, June 3 to Friday, June 9

**Probabilistic and analytic methods in discrete mathematics**

**HERBERT S. WILF** (University of Pennsylvania), Chair

Discrete mathematics, including graphs, algorithms, and combinatorics, progresses by a mixture of discrete and continuous methods. This conference will focus on the application of continuous methods.

These include analytical, probabilistic, asymptotic, and other techniques from analysis. Particular attention will be paid to the distribution of interesting and important combinatorial structural properties among families of objects, such as graphical evolution, asymptotics of kinds of objects, probability-based existence theorems, analytic methods based on generating functions, probabilistic theory of algorithms, and so forth.

Members of the Organizing Committee: Edward Bender (University of California, San Diego), Bela Bollobas (Louisiana State University) and Joel H. Spencer (NYU, Courant Institute).

Saturday, June 10 to Friday, June 16

**Statistical analysis of measurement error models and applications**

**RAYMOND J. CARROLL** (Texas A & M University), Co-Chair

**WAYNE A. FULLER** (Iowa State University), Co-Chair

**LEON J. GLESER** (Purdue University), Co-Chair

Measurement error models describe functional relationships among variables which can only be observed subject to random errors of measurement. Well known examples include: linear and nonlinear errors-in-variables regression models, calibration and inverse regression models, factor analysis and latent structure models, and econometric simultaneous equation models. Such models are used in virtually every scientific and technological discipline, including recent applications in medicine and the life sciences, chemometrics, geology, sample surveys, and time series (signal extraction). Different terminology and mathematical formulations mask basic similarities in the models used in different disciplines, and have hindered communication. Often, problems still unresolved in one application have been successfully treated in another.

Measurement error models have also historically served as an important proving ground for theoretical approaches to statistical inference. Difficulties with classical methods have motivated Bayesian, adaptive and empirical Bayesian, and partial and marginal likelihood approaches. Robustness theory and diagnostic methodology are needed, and have been the focus of recent research. Computing problems arising in constructing related statistical software are frequently nontrivial. A dialogue with numerical analysts working on "total least squares" methods would be mutually beneficial.

Topics to be covered will include:

1. Overview of models and their use in applications;
2. General approaches to inference on measurement error models;
3. Computational and diagnostic procedures;
4. Robust inference.

Many of the measurement error models used in recent applications have been nonlinear (logistic, log-linear). It is expected that such models will receive particular attention at the conference.

The primary aim of the conference is to promote communication between methodologists, theoreticians, and numerical analysts, and thus to accelerate progress in this important and rapidly growing area of research.

Members of the Organizing Committee: G. W. Stewart (University of Maryland) and J. H. Ware (Harvard School of Public Health).

Saturday, June 17 to Friday, June 23

**Relationships between continuum theory and the theory of dynamical systems**

**MARCY BARGE** (Montana State University), Co-Chair

**WILLIAM T. INGRAM** (University of Houston), Co-Chair

In the last few years interaction between continuum theory and the theory of dynamical systems has begun to take place. This conference is intended to encourage and stimulate more extensive interaction between these disciplines by bringing together active researchers in each area along with those who are already pursuing problems arising from the interaction. Major talks will be aimed at bridging gaps between the disciplines. The emphasis of these talks will be on communicating what is known in a given area which might be of interest to those in other areas as well as what some of the unsettled questions are.

Topics for consideration for the conference include, but certainly are not limited to: (1) Caratheodory theory of prime ends, (2) Sarkovskii’s Theorem, (3) attractors, (4) inverse limits, (5) the Smale horseshoe, (6) chainable and circle-like continua with relations to dynamics of maps of the interval and the circle, (7) indecomposable continua and (8) plane homeomorphisms.
Saturday, June 17 to Friday, June 23

**Statistical multiple integration**

NANCY FLOURNOY (American University), Co-Chair
ROBERT TSUTAKAWA (University of Missouri, Columbia), Co-Chair

Numerical multiple integration has arisen as an important research area in a variety of statistical contexts: posterior expectation, multivariate eigenvalue estimation, hierarchical modeling with latent variables, imputation methods for missing values, marginal likelihood functions, categorical data analysis with random effects, variance components, modeling multivariate distributions.

As a consequence of this growing need, contributions have been made by researchers in different areas. Because goals may vary, the techniques developed also vary. The present proposal is designed to bring together researchers from different areas within the statistical community and between the statistical, numerical, analytic and scientific computing communities. In particular, we plan to invite researchers concerned with (a) faster integration methods, (b) numerical analysis, (c) algorithmic development, and (d) increasing multiple integration capabilities.

A key feature of the conference is the collection of diverse disciplines concerned with this area: numerical analysts, statisticians, geometers, algorithm specialists.

Some of the topics planned for discussion are: (i) Bayesian statistics in computing, (ii) importance sampling in high dimensions, (iii) approximation methods, (iv) Gaussian quadrature, (v) geometric asymptotic methods, (vi) supercomputer random number methods.

There will be talks on the state of the art with respect to the four mathematical constituencies. Working groups will be organized to delineate new directions and to develop a multidisciplinary attack. We also plan to have contributed paper sessions, and especially sessions for new PhDs.

Members of the Organizing Committee: Gene Golub (Stanford University) and George Marsaglia (Florida State University).

Saturday, June 24 to Friday, June 30

**Integral geometry**

LEON EHRENPREIS (Temple University), Co-Chair
ERIC GRINBERG (Temple University), Co-Chair

Integral geometry combines mathematics from such diverse fields as Lie groups, microlocal analysis, combinatorics, and harmonic analysis. The powerful techniques of computed tomography that allow doctors to detect tumors noninvasively grow out of this mathematics. The unifying theme of integral geometry is integration: information on one space is integrated or averaged to give data on another space. Goals vary from inversion of Radon transforms, to understanding geometric properties of manifolds from integral-geometric data, to imaging organs in the body from X-ray projections.

The aims of the conference are to explore the interplay between the various facets of integral geometry and to isolate and unify common themes. Other goals are to report recent developments, to clarify main directions for future research, and to encourage interaction between participants.

Topics to be included are classical, generalized, non-linear, finite, and singular Radon transforms as well as Radon transforms on supervarieties; classical integral geometry; integral geometric themes in Lie groups, Lie algebras, and homogeneous spaces, real analysis, partial differential equations, group representations, and mathematical physics; and finally applications, such as singular value decompositions and limited data problems, to computed tomography in all modalities.

Members of the Organizing Committee: Fulton Gonzales, (Tufts University) and Todd Quinto (Tufts University).

Saturday, July 8 to Friday, July 14

**Finite and algebraic groups: Modular representations and cohomology**

JON F. CARLSON (University of Georgia), Chair

The conference will explore problems in the modular representation theory of finite groups and of algebraic group defined over fields of finite characteristic. Recently, several promising techniques of broad interest have been under development. The theories of categories, derived categories and the accompanying Morita theory are current topics of study in programs concerned with both the Lusztig conjectures for algebraic groups and the structure of blocks of finite-group algebras. Homological methods in such forms as complexes of modules or subgroups and support varieties.
Joint Summer Research Conferences

for cohomology rings have been used in the investigation of modules over finite and algebraic groups. Results and techniques have found application in the study of local methods of representation theory and in topology. A primary aim of the conference is to foster interaction among researchers in seemingly diverse areas of representation theory and its applications.

Members of the Organizing Committee: Jonathan L. Alperin (University of Chicago) and Brian Parshall (University of Virginia).

Saturday, July 15 to Friday, July 28

The geometry of Riemann surfaces and discrete groups

Irwin Kra (SUNY at Stony Brook), Co-Chair
Bernard Maskit (SUNY at Stony Brook), Co-Chair

There has been a continuing expansion of both the scope and depth of the research in a number of subjects connected to the different kind of geometric structures associated with Riemann surfaces; in particular, the structures associated to uniformizations. This conference will emphasize important open questions currently being investigated including the following topics.

1. Relations between different embeddings of Teichmüller and reduced Teichmüller space into number space
2. Computations of the global and infinitesimal forms of various metrics in various embeddings of Teichmüller space
3. Descriptions of fundamental domains for the modular groups acting on Teichmüller space
4. Iteration of rational maps and relations of this theory with the theory of Kleinian groups
5. Characterization of discreteness; relations between Kleinian groups and the surfaces they uniformize
6. Infinitely generated Kleinian groups and infinite dimensional Teichmüller spaces
7. Three dimensional hyperbolic manifolds and Thurston's uniformization theorem
8. The Hausdorff dimension of the limit set of Kleinian group and the eigenvalue spectrum
9. Discrete convergence groups and other generalizations of Kleinian groups
10. Quasiconformal and quasiregular mappings in space including the one dimensional case
11. Eichler cohomology of Kleinian groups and the relations to automorphic forms
12. Projective structures on Riemann surfaces

The organizers of the conference expect to take advantage of the opportunity provided by this meeting to celebrate the seventy fifth birthday of Lipman Bers. Two or three days of special lectures will be devoted to mark this event.

Members of the Organizing Committee: Clifford Earle (Cornell University), Fredrick W. Gehring (University of Michigan), Linda Keen (Lehman College), Albert Marden (University of Minnesota) and Scott Wolpert (University of Maryland).

Saturday, July 29 to Friday, August 5

Inverse problems in partial differential equations

Richard Ewing (University of Wyoming), Co-Chair
William Rundell (Texas A & M University), Co-Chair

In the early part of this century, J. Hadamard formulated his classic trinity of existence, uniqueness and continuous dependence on data for solutions of a physical system. The necessity to only consider problems, correctly set in the sense of Hadamard, strongly influenced the scientific outlook and hence the choice of problems tackled by applied mathematicians for many decades. By the middle of the century this viewpoint had begun to change. To quote from Courant, "this rational ideal of causal-mathematical determination was gradually eroded by confrontation with physical reality. Nonlinear phenomena, quantum theory, and the advent of powerful numerical methods have shown that 'properly posed' problems are not the only ones which appropriately reflect real phenomena." Today, applications involving ill-posed problems are pervasive. This conference will focus on inverse problems, most of which are inherently "incorrectly set" problems.

The general theme of the conference will be methods for the recovery of unknown coefficients and unknown geometries from differential equations. Those methods which have already developed a computational component will be particularly emphasized. Topics will include: identification of unknown parameters, coefficients, and functions in differential equations; the determination of hidden obstacles or unknown boundaries; the recovery of initial states of a system.

Members of the Organizing Committee: David Colton (University of Delaware) and Michael Vogelius (University of Maryland).
1989 Summer Research Institute

Several Complex Variables and Complex Geometry
University of California, Santa Cruz, July 10–30

The thirty-seventh Summer Research Institute sponsored by the American Mathematical Society will be devoted to Several complex variables and complex geometry and will take place at the University of California, Santa Cruz. Members of the Organizing Committee are: Eric Bedford, Indiana University at Bloomington; John D’Angelo, University of Illinois at Urbana-Champaign, Robert E. Greene, University of California, Los Angeles; and Steven G. Krantz, Washington University (chair). It is anticipated that the institute will be partially supported by a grant from the National Science Foundation. Proceedings of the institute will be published in the AMS series Proceedings of Symposia in Pure Mathematics.

This topic was selected by the 1987 Committee on Summer Institutes and Special Symposia whose members were Eric Friedlander, Steven L. Kleiman, Paul H. Rabinowitz, Thomas C. Spencer, Robert B. Warfield, Jr. and John Wermer (chair).

In 1975, a summer institute was held on several complex variables; prior to that an institute was held in 1953 (to celebrate the solution of the Levi problem). The institute for 1989 marks a substantial lapse of time and at least as great an increment of growth in the subject. There follows a discussion of some of the new developments which will be treated during this institute.

The partial differential equations that define holomorphic functions are called the Cauchy-Riemann equations (or the \( \bar{\partial} \) equation). Theorems about these equations go hand in hand with the solution of function-theoretic problems, because one can perform real variable constructions with smooth functions and correct them with the \( \bar{\partial} \) equation. In these constructions, regularity at the boundary is of crucial importance. However the \( \bar{\partial} \)-Neumann problem is not elliptic at the boundary and new techniques had to be developed by Kohn to obtain so-called subelliptic estimates on strongly pseudoconvex domains; local boundary regularity follows. More recently, Catlin has found necessary and sufficient conditions for subellipticity. The conditions are in terms of order of contact of complex varieties with the boundary and reveal surprising connections between partial differential equations and algebraic geometry—especially the intersection of theory of complex varieties.

A second partial differential equation arising in several complex variables is the complex Monge-Ampère equation. This equation is a nonlinear generalization of the Laplacian. This equation is important in plurisubharmonic function theory, the construction of Kähler metrics, and in the potential theory of several complex variables. The existence and regularity theory for this equation does not fit any standard mold and has brought many surprises.

Biholomorphic and proper maps have been intensely studied in recent years. In 1974, C. Fefferman proved that biholomorphic mappings of strongly pseudoconvex domains continue smoothly to the boundary. More recently, new methods have been found which apply to broader classes of domains and to proper mappings and correspondences as well. At the same time, proper mappings of domains in different dimensions are revealing surprising pathologies. These pathologies, and the methods used to construct them, are related to the inner functions of Aleksandrov and Low. Inner functions have aided in the resolution of a number of problems in constructive function theory.

Yet another method in holomorphic mapping theory is complex analytic dynamics. Fifty years ago H. Cartan used this method to study automorphisms of domains in \( \mathbb{C}^n \). More recently, these methods have been used to obtain new constructions of Fatou-Bieberbach mappings (entire mappings with "small range") and to prove new characterizations of automorphisms.

The intersection theory of complex analytic varieties has been used by D’Angelo to describe the geometry of real hypersurfaces in \( \mathbb{C}^n \). When the hypersurface bounds a domain, then the boundary geometry influences the function theory on the interior. The invariant metrics of Bergman, Carathéodory, Kobayashi/Royden are a useful device for mediating between boundary geometry and interior function theory. The theories of Hardy spaces, Bloch functions, the Lindelöf Principle, and so forth, are being increasingly treated with this metric language. In addition, the work of Lempert on extremal discs for the Kobayashi/Royden metric has tied invariant met-
rics to the Monge-Ampère equation and to mapping problems.

The function theory of complex manifolds is also predominantly geometric. Even for topologically trivial complex manifolds, many different function theories can arise: the curvatures of complex geometries specify the possibilities. If one specializes to Hermitian symmetric spaces, Kähler manifolds, parabolic manifolds, inbedded CR manifolds, or other contexts with structure, then a subject rich in texture emerges. In the last decade powerful machines such as nonlinear partial differential equations, positive and negative vector bundles, Hodge theories and vanishing theorems have been exploited to further the subject.

Complex analysis in several variables has grown considerably since 1975. A significant component of this growth has stemmed from the interaction with other parts of mathematics. The 1989 institute will make explicit many of these connections and review several of the major achievements stemming from them. One principal purpose of the institute is to foster and encourage further interaction among complex analysts with diverse interests.

A tentative list of the topics to be addressed follows. Please note, however, that the program is subject to change.

**Week One: Complex Function Theory**

Biholomorphic and proper maps, complex potential theory, plurisubharmonic functions, approximation theory, complex analytic dynamics, convolution equations, analytic multifunctions, inner functions.

**Week Two: Complex Manifolds and Complex Geometry**

Hermitian and Kähler geometry, curvature, holomorphic mappings, invariant metrics, deformations, parabolic manifolds, finite type conditions, positive and negative vector bundles, vanishing theorems, Hodge theory.

**Week Three: Analysis and Partial Differential Equations**

Cauchy-Riemann equations, CR geometry of hypersurfaces, CR functions, complex Monge-Ampère equation, integral kernels and asymptotics, pseudoconvexity, hyperfunctions.

Accommodations will be available in the campus residence halls for participants; cafeteria style meals will be available. All facilities will be accessible to the handicapped.

Information on housing, dining, travel and the local area will be sent to invited participants in the spring. Each participant will pay a registration fee and a social fee to cover the costs of social events scheduled during the institute.

Those interested in receiving an invitation to participate in the institute should send the following information to Wayne S. Drady, Summer Institute Conference Coordinator, American Mathematical Society, Post Office Box 6248 Providence, RI 02940 prior to April 1, 1989 or through electronic mail WSD@MATH.AMS.COM.

Please type or print the following:

1. Full name;
2. Mailing address;
3. Telephone number and area code for office and home;
4. Which week or weeks you wish to attend;
5. Your scientific background relevant to the institute topic;
6. Financial assistance requested;
7. Indicate if support is not required, and if interested in attending even if support is not offered.

Requests for invitations will be forwarded to the Organizing Committee for consideration. Requests will be considered after April 1, 1989, and applicants selected will receive formal invitations and notification of financial assistance beginning in mid-May.


April

May

July

August

September

October

December

November 1988


18–19. Quantitative Approaches to Diabetes, Sydney, Australia. (April 1988, p. 638)
Meetings and Conferences

28-December 1. Conference on the Theory of Numbers and Automorphic Form, Kyoto University, Japan. (October 1988, p. 1240)

December 1988

5-7. Conference on Operator Theory, Kyoto University, Japan. (October 1988, p. 1240)


7-10. Conference on Research on Complex Analytic Geometry and Related Topics, Kyoto University, Japan. (October 1988, p. 1240)

*7-10. SIAM Workshop on Random Media and Composites, Leesburg, Virginia.


*8-10. Frontiers of Science, Moscow, Union of Soviet Socialist Republics.

SOVIET ORGANIZING COMMITTEE: M. Berenfeld, Y. Cherniak, E. Nadgornyi, and I. Uspenskii.

INFORMATION: Committee of Concerned Scientists, Inc., 330 Seventh Avenue, Suite 608, New York, New York 10001, 212-693-2560. (For further information, see the News and Announcements section of this issue of Notices.)

8-10. Conference on Mathematical Programming and Its Related Field, Kyoto University, Japan. (October 1988, p. 1240)


PRINCIPAL SPEAKERS: E. Bombieri; C. Foias; F. Freyd; G. Lallement; R. Murty; S. Smale; J. Taylor.

PROGRAM: There will be special sessions on ergodic theory and dynamical systems; number theory; geometry; category theory; semigroups, languages and computation; mathematical education.

INFORMATION: J. B. Wilker, Department of Mathematics, University of Toronto, Toronto, Ontario M5S 1A1, Canada.


PROGRAM COMMITTEE: J.-Y. Girard; P. Martin-Lof (Chairman); J. McCarthy; D. Prawitz; A. Salomaa; J. Shepherdson.


12-17. International Course on Computational Geometry, Dipartimento de Matematica, Università, Catania, Italy. (May/June 1988, p. 730)


14-16. Raj Chandra Bose Memorial Conference on Combinatorial Mathematics and Applications, Calcutta, India. (July/August 1988, p. 894)

15-18. Interdisciplinary Conference on Axiomatic Systems, Ohio State University, Columbus, Ohio. (October 1988, p. 1241)


27-31. Holiday Symposium on Fermat's Last Theorem, New Mexico State University, Las Cruces, New Mexico. (September 1988, p. 1057)

January 1989

2-5. International Colloquium in Ring Theory, Bar-Ilan University, Ramat-Gan, Israel. (May/June 1988, p. 730)

2-5. Fifth Haifa Matrix Conference, Technicon City, Haifa, Israel. (September 1988, p. 1057)

2-20. Conference on Automatic Continuity and Banach Algebras, Australian National University, Canberra. (October 1988, p. 1241)

3-10. Workshop on Two Phase Waves in Fluidized Beds, Sedimentation, and Granular Flows, Institute for Mathematics and Its Applications, Minneapolis, Minnesota. (September 1988, p. 1057)


4-7. Second International Workshop on Artificial Intelligence and Statistics, Fort Lauderdale, Florida. (October 1988, p. 1241)

6-10. Sixth Texas International Symposium on Approximation Theory, College Station, Texas. (Note date change from April 1988, p. 638)

7-10. Conference on the Arithmetic of Algebraic Curves, University of Arizona, Tucson, Arizona. (Note date change from September 1988, p. 1057)

8-10. Symposium in Honor of the Seventieth Birthday of Ted Harris, Los Angeles, California. (May/June 1988, p. 730)

8-11. First Caribbean Conference on Fluid Dynamics, Saint Augustine, Trinidad, West Indies. (June 1987, p. 686)


9-27. Workshop on Theoretical Fluid Mechanics and Applications, Trieste, Italy. (October 1988, p. 1241)
Meetings and Conferences


**INFORMATION:** M. Foulkes, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


**INFORMATION:** H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

14-17. 1988-1989 Annual Meeting of the Association for Symbolic Logic, University of California, Los Angeles, California.

**PROGRAM:** This will be a meeting of the Association by itself. The program will include a symposium on type theory with J. Mitchell, A. Scedrov, and M. Beeson.

**INVITED SPEAKERS:** T. Slaman; M. Foreman; A. Lachlan; A. MacIntyre; R. Cartwright; N. Immerman; E. Keenan.

**INFORMATION:** V. Putnam, Journal of Symbolic Logic, 7332 Mathematical Sciences, University of California, Los Angeles, Los Angeles, California 90024, 213-825-1878.

14-19. American Association for the Advancement of Science Annual Meeting, San Francisco, California. (Note date change from May/June 1988, p. 731)

*16-20. Nonlinear Wave Equations, George Mason University, Fairfax, Virginia. (Note: The dates originally listed on p. 638 in the April 1988 issue of Notices were incorrect.)

17-19. Conference on Flow Instability and Structure of Turbulence, Kyoto University, Japan. (October 1988, p. 1241)

18-20. The McKnight Lecture Series: Classification of Finite Simple Groups, University of Miami, Coral Gables, Florida. (October 1988, p. 1241)


**INFORMATION:** D. Joseph, Institute for Mathematics and its Applications, Minneapolis, Minnesota, 55455, 612-624-6066.


**February 1989**


6-10. Minisymposium on Plasticity, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (September 1988, p. 1057)

19-23. Analyse quantitative de la sensibilité en optimisation, Centre de recherches mathématiques, Université de Montréal. (September 1988, p. 1057)


*27-March 3. X Escola de Álgebra, Vitória ES, Brazil.

**INFORMATION:** A. Hefez, Departamento de Matemática, Universidade Federal do Espírito Santo, 29069 Vitória ES, Brazil.

**March 1989**


**PURPOSE:** The aim of the conference is to exchange information on the fast-developing area of parallel computers with distributed memory. This includes, but is not limited to hypercubes, meshes, and massively parallel ensembles of single-bit processors.

**INFORMATION:** B. Hickey, Conference Administrator, 415-969-6920.

6-10. Workshop on Ellipticity in Evolution Equations, Institute for Mathematics and its Applications, Minneapolis, Minnesota. (September 1988, p. 1058)

13-18. East European Category Seminar (EECS '89), Sofia, Bulgaria. (September 1988, p. 1058)


**ORGANIZER:** R. Glowinski, University of Houston.


27-30. Twentieth Annual Iranian Mathematical Conference, University of Tehran, Tehran, Iran. (October 1988, p. 1242)


30-April 1. Conference Honoring Richard S. Varga, Kent, Ohio. (October 1988, p. 1242)

*31-April 1. Fifth South-Eastern Analysis Meeting (SEAM 5), University of Georgia, Athens, Georgia.

**INFORMATION:** K. Clancey, Department of Mathematics, University of Georgia, Athens, Georgia 30602.

**April 1989**


3-5. Third SIAM Conference on Optimization, Boston, Massachusetts. (October 1988, p. 1242)


10-13. IEEE Artificial Neural Networks Conference, Sheraton International Conference Center, Reston, Virginia. (Note date change, March 1988, p. 465)


13-15. Operators and Function Theory: The Role of de Branges’s Spaces, University of Arkansas, Fayetteville, Arkansas. (September 1988, p. 1058)


INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


17-21. Minisymposium on Front Tracking in a Supercomputer Environment, Minneapolis, Minnesota. (October 1988, p. 1243)

17-28. Topical Meeting on Hyperbolic Geometry and Ergodic Theory, Trieste, Italy. (October 1988, p. 1243)


27-29. Third Annual Conference on Undergraduate Research, Trinity University, San Antonio, Texas. (October 1988, p. 1243)


PROGRAM COMMITTEE: K. Manders, Chair; D. Marker; W. Tait.

PROGRAM: The committee plans to emphasize philosophical aspects of logic, to commemorate the fact that ASL has recently assumed editorial responsibility for the Journal of Symbolic Logic. There will also be sessions on model theory and the foundations of mathematics.

CALL FOR PAPERS: Contributed papers in all areas of logic are welcomed from ASL members. Abstracts should be submitted to the Program Chairman, at the address given below, by February 12, 1989 and should be no longer than one page, double-spaced, including references. The author’s name and address should appear on all abstracts.

INFORMATION: K. Manders, Program Chairman, Philosophy Department, 1001 CL, University of Pittsburgh, Pittsburgh, Pennsylvania 15210.

May 1989

4-5. Twentieth Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pennsylvania. (September 1988, p. 1058)


SPONSORS: SIAM Activity Group on Control and Systems Theory.

19-20. Central Section Meeting of the AMS, Loyola University, Chicago, Illinois.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


22-24. Workshop on Vortex Methods, Mathematical Sciences Research Institute, Berkeley, California. (September 1988, p. 1059)


SPONSOR: SIAM Activity Group on Linear Algebra.

ORGANIZER: J. Lewis, Boeing Computer Services.


INVITED SPEAKERS: S. S. Antman (Maryland); J. Carr (Heriot-Watt, Scotland), W. N. Everitt (Birmingham, England), J. K. Hale (Georgia Tech.); R. E. O’Malley (Rensselaer).

ORGANIZERS: A. Wood; D. W. Reynolds.

INFORMATION: D. W. Reynolds, School of Mathematical Sciences, NIHE, Dublin 9, Republic of Ireland. Telephone: Dublin 370077, ext. 290

22-June 3. NATO Advanced Study Institute on Orthogonal Polynomials and Their Applications, The Ohio State University, Columbus, Ohio. (September 1988, p. 1059)


PROGRAM: In addition to five invited speakers, there will be 40-minute contributed talks. Abstracts must be received by April 15, 1989.
Meetings and Conferences

INFORMATION: D. Davis or D. Johnson, Department of Mathematics, Lehigh University, Bethlehem, Pennsylvania 18015, 215-758-3756.

*26–30. AMS Pure Mathematics Symposium on Complex Geometry and Lie Theory, Sundance, Utah.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


29–June 1. Third International Conference in Mathematics: Fractional Calculus and Its Applications, Nihon University, Tokyo, Japan. (May/June 1988, p. 731)


INFORMATION: B. Verducci, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

30–June 30. Analytic Number Theory, Modular Forms and Related Topics, Centre de recherches mathématiques, Université de Montréal. (September 1988, p. 1059)


June 1989


*3–August 5. Joint AMS-IMS-SIAM Summer Research Conferences in the Mathematical Sciences, Humboldt State University, Arcata, California.

INFORMATION: C. Kohanski, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.


4–9. Geometrical and Algebraical Aspects in Several Complex Variables, Cetraro (CS), Italy.

INVITED SPEAKERS: C. A. Bernstein; J. E. Bjork; L. Ehrenpreis; T. Kawai; S. Krantz; P. Schapira; W. Stoll; E. Vesentini; A. Yger.

INFORMATION: D. C. Struppa, Department of Mathematical Sciences, George Mason University, 4400 University Drive, Fairfax, Virginia 22030.


5–8. Fourth Annual Symposium on Logic in Computer Science (LICS), Asilomar, California. (October 1988, p. 1244)


6–10. Analytic Number Theory, Centre de recherches mathématiques, Université de Montréal. (September 1988, p. 1059)


PROGRAM: The program will include lectures by invited speakers and contributed talks. These topics will be published in the proceedings of the conference.

INVITED SPEAKERS: A. Balakrishnan, UCLA; L. H. Erbe, Alberta; H. Hermes, University of Colorado; V. Lakshmikantham, University of Texas, Arlington; I. Lasiecka, Virginia; S. M. Meerkov, Michigan; G. R. Sell, Minnesota; D. Siljak, Santa Clara; O. Staffans, Helskinki.

ORGANIZING COMMITTEE: S. Elaydi, UCCS; J. Craig, CC; M. Z. Nashed, Delaware; A. Peterson, Nebraska; C. Fosha, UCCS.

INFORMATION: S. Elaydi, Department of Mathematics, University of Colorado, Colorado Springs, Colorado 80933-7150, 719-593-3336.


ORGANIZERS: Department of Mathematics of the National University of Singapore, and the Singapore Mathematical Society.

PROGRAMS: The first three days (June 8–10) will be devoted to a workshop. One-hour invited lectures and 20-minute contributed talks will be presented from June 12–16.

CONTRIBUTED PAPERS: The abstract should be double-spaced with wide margin, of at most one A4 size page, and contain the names of the author(s) and the institution(s) of affiliation. Deadline: March 31, 1989.

INFORMATION: Abstracts and requests for registration forms should be addressed to: Jiaan-Hua Lou, Organizing Secretary, Singapore Probability Conference, Department of Mathematics, National University of Singapore, Lower Kent Ridge Road, Singapore 0511, Republic of Singapore.


14–17. International Conference on Dynamical Systems, Control Theory, and Applications, Wright State University, Dayton, Ohio. (October 1988, p. 1244)


27–30. Second Conference of the International Federation of Classification So-
Meetings and Conferences

July 1989


INFORMATION: Logic at Botik '89, Post Office Box 11, Program Systems Institute of the Union of Soviet Socialist Republics Academy of Sciences, 152140 Pereslavl-Zalessky, Union of Soviet Socialist Republics.

*2-16. Fifth Workshop on Nonlinear Evolution Equations and Dynamical Systems, Kolymbari near Chania, Crete.

TOPICS: The topics covered will include integrable dynamical systems (nonlinear ODEs and PDEs), near integrable and nonintegrable model equations, applications in classical and quantal physics (elementary particles, solids, statistical mechanics, fluids, plasmas, etc.) and elsewhere (oceanography, biophysics, etc.) The techniques discussed will range from pure mathematics through numerical computations to applicable theory and experiments.

INFORMATION: Please address all correspondence to NEEDS '89, c/o F. Calogero, Dipartimento di Fisica, Universita di Roma “La Sapienza,” p. Aldo Moro 2, 00185 Roma (Italy) with copy to NEEDS '89, c/o A. Verganelakis, N. R. C. Demokritos, Post Office Box 60228, 15310 Agia Paraskevi, Attiki (Greece).


*3-7. Fourteenth IFIP Conference on System Modelling and Optimization, Leipzig, German Democratic Republic.

Sponsors: International Federation of Automatic Control (IFAC) and the International Federation of Operational Research Societies (IFORS).

PURPOSE: The conference is designed to discuss recent advances in the mathematical representation of engineering, sociotechnical and socio-economical systems as well as in the optimization of their performances.

INFORMATION: K. Tanner, Leipzig University of Technology, Department of Mathematics and Informatics, PF 66, Leipzig, 7030 German Democratic Republic. Telephone: Leipzig 32 80 28, 3 91 33 16, 3 92 80.


INFORMATION: T. Porter, School of Mathematics, University of Wales, Bangor, Gwynedd LL57 1UT, United Kingdom. Telephone: 0248-351151.


PURPOSE: The main aim of the conference is to provide a forum for presentation and exchange of information, experiences, views and ideas between people engaged in the topic of the conference. The educational levels considered are secondary and tertiary levels. The scientific program will consist of lectures, workshops, exhibitions, and demonstrations.

INFORMATION: M. Niss, Chairman, IFMUFA Roskilde University Centre, Post Office Box 260, DK-4000 Roskilde, Denmark.


PROGRAM: There will be special sessions for contributed talks covering a wide range of topics in combinatorial theory. The invited lectures are to be published by Cambridge University Press.

INFORMATION: Twelfth BCC, School of Mathematics, University of East Anglia, Norwich NR4 7TJ, United Kingdom.

*3-7. International Symposium on Approximation, Optimization, and Computing, Dalian University of Technology, Dalian, China.

Sponsors: University of Regina; the International Association for Mathematics and Computers in Simulation.

INFORMATION: Conference and accommodation information and guidelines for submitting papers may be obtained from A. G. Law or C.-L. Wang, University of Regina, Saskatchewan, Canada S4S 0A2. Telephone: 306-585-4148.

*10. Tutorial Short Courses, Trinity College, Dublin, Ireland.

PROGRAM: Several one-day tutorial short courses will be held on the day before the Sixth International Conference on the Numerical Analysis of Semiconductor Devices and Integrated Circuits (July 11-14). Each of these will be given by one or two experienced instructors. The appropriate Short Course Lecture Notes will be available at the beginning of each course.


10-12. International Conference on Computational Techniques and Applications, Griffith University, Brisbane. (April 1988, p. 639)


INFORMATION: A. P. Street, Department of Mathematics, University of Queensland, St. Lucia, Brisbane, Queensland 4067, Australia.


*10-30. AMS Summer Research Institute on Several Complex Variables and Complex Geometry, University of California, Santa Cruz, California.

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.
Meetings and Conferences


INFORMATION: NASECODE VI Conference, Institute for Numerical Computation and Analysis, Post Office Box 2, Dun Laoghaire, Ireland.


INFORMATION: J. S. Byrnes, President, Prometheus Inc., 21 Arnold Avenue, Newport, Rhode Island 02840, 401-849-5389.

*17–21. SIAM Annual Meeting, San Diego, California.

ORGANIZERS: J. Bunch and R. Bank, University of California, San Diego.


CONFERENCE THEMES: Set theory; model theory; boolean algebras; proof theory and arithmetic; logic for computer science and recursion theory; philosophical logic and applications.

PROGRAM: The program will include four series of lectures on recent results: descriptive set theory (A. Kechris/A. Louveau); stability theory (S. Buechler/A. Pillay); complexity theory (U. Schöning); and subsystems of arithmetic (S. Buss).

CALL FOR PAPERS: Abstracts of contributed papers (of about one page in length, double spaced) should be sent, before April 1, 1989, to the address given below.


*24–27. Gauss Symposium on Mathematics and Theoretical Physics, Guaruja, SP, Brazil.

SPONSORS: Gauss Institute, Canada; the Catholic University of Santos, Brazil.

INFORMATION: Gauss Symposium, Pós-Graduação e Pesquisa - UniSantos, Rua Euclides da Cunha, no. 241, CEP 11060, Santos, SP, Brazil.


INFORMATION: U. Bottazzini, Università di Bologna, Dipartimento di Matematica, Piazza di Porta San Donato 5, 40127 Bologna, Italy.

30–August 4. Sixteenth Annual Conference and Exhibition on Computer Graphics and Interactive Techniques (SIGGRAPH '89), Hynes Auditorium, Boston, Massachusetts. (March 1988, p. 466)


August 1989


INFORMATION: M. Karoński, Department of Discrete Mathematics, Adam Mickiewicz University, Matejki 48/49, 60-769 Poznań, Poland.


CONFERENCE TOPICS: Emphasis will be placed on the structure of finite algebras, their clones, and locally finite varieties.

PROGRAM: One-hour invited lectures, 25-minute contributed papers, problem session.

ORGANIZER: József Attila University, Szeged, Hungary.

INFORMATION: A. Szendrei, Bolyai Institute, Aradi várterületi 1, H-6720 Szeged, Hungary.


CALL FOR PAPERS: Those wishing to present papers at the conference should submit an abstract in English (limited to one typed page) related to any topics of the conference theme no later than January 31, 1989 to the conference organizer at the address given below. Notification of the acceptance of the abstracts will be given by March 15, 1989. The deadline for submission of the final version of papers is April 15, 1989.

INFORMATION: Y. Dodge, Conference Organizer, Université de Neuchâtel, Groupe d'Informatique et de Statistique, 6, Pierre-à-Mazel 7, CH-2000 Neuchâtel, Switzerland. Telephone: (038) 25 72 05.


*28–September 2. Second International Conference on Function Spaces, Poznań, Poland.

INFORMATION: J. Musielak, Institute of Mathematics, A. Mickiewicz University, Matejki 48/49, 60-769 Poznań, Poland.

28–September 8. Topical Meeting on Variational Problems in Analysis, Trieste, Italy. (October 1988, p. 1245)


September 1989

*4–8. Centenary Workshop of Heun's Equation: Theory and Applications,
Tagungsstätte Schloß Ringberg, D-8183 Rottach-Egern am Tegernsee (Bavarian Alps, Federal Republic of Germany).

PROGRAM: Expository and research papers on all aspects of Heun’s equation and confluent forms of Heun’s equations. An important part of the workshop will be devoted to collecting and reviewing results from mathematics, physics, and engineering in order to propose canonical forms and standard forms for solutions. The number of participants will be limited to not more than 60.

CALL FOR PAPERS: Application for participation and submission of extended abstracts are due before January 31, 1989.

INFORMATION: A. Seeger, Max-Planck-Institut für Metallforschung, Heisenbergstraße 1, D-7000 Stuttgart 80, Federal Republic of Germany or A. Ronveaux, Facultés Universitaires, B-4010 Namur, Belgium.


ORGANIZERS: L. Kossuth University; J. Bolyai Mathematical Society; the Regional Committee of the Academy of Sciences.

INFORMATION: I. Gaal, Kossuth Lajos University, Mathematical Institute, 4010 Debrecen Pf.12, Hungary.

* 8–14. COSMEX '89: International Conference on Stochastic Methods in Experimental Sciences, Technical University of Wroclaw, Poland.

PROGRAM: COSMEX '89 will concentrate on stochastic methods oriented to applications in various branches of experimental sciences. In particular, applications in physical sciences and engineering are welcome.

CALL FOR PAPERS: Papers presenting original research on the following topics are being sought: stochastic analysis in physical sciences; chaos and order; synergetics; stochastic dynamical systems; identification and time series; function fitting and regression analysis; design of experiments; algorithms of experimental design; computer-oriented and robust methods in data analysis; quality control, dimensional analysis and theory of measurement.

DEADLINE FOR ABSTRACTS: Two copies of a camera-ready abstract of no more than two double-spaced pages should be submitted by March 1, 1989 to the address below.

INFORMATION: A. Weron, Institute of Mathematics, Politechnika, 50-370 Wroclaw, Poland.

* 11–15. Fifth International Conference on Numerical Methods in Engineering, Lausanne, Switzerland.

INFORMATION: R. Gruber, GASOV/Centre de calcul, EPFL, 1015 Lausanne, Switzerland.

16–October 20. Sixth World Congress on Medical Information, Beijing, China. (April 1988, p. 639)


INFORMATION: L. T. M. Berry, Director, Teletraffic Research Centre, University of Adelaide, GPO Box 498, Adelaide, SA 5001, Australia.


ORGANIZERS: M. Wheeler, Rice University, and W. Fitzgibbon, University of Houston.


CONFERENCE TOPICS: Integral equations; numerical methods for integral equations; inverse scattering problems; inverse spectral problems; numerical methods for inverse problems.

PROGRAM: The scientific program of the conference includes lectures by invited speakers and short communications.

INFORMATION: Institute of Mathematics at the Bulgarian Academy of Sciences, Conference on Integral Equations and Inverse Problems, Post Office Box 373, 1090 Sofia, Bulgaria.


October 1989


CALL FOR PAPERS: Extended abstracts (no fewer than four pages) are to be submitted in triplicate no later than March 31, 1989 to the address given below.

INFORMATION: C. Ulrich, Institut für Informatik, Universität Basel, Mittlere Strasse 142, CH-4056 Basel, Switzerland.


INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

27–28. Central Section Meeting of the AMS, Ball State University, Muncie, Indiana. (May/June 1988, p. 732)

INFORMATION: W. Drady, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

November 1989


ORGANIZER: R. Barnhill, Arizona State University.

Meetings and Conferences

December 1989


SPONSOR: SIAM Activity Group on Supercomputing.
ORGANIZER: J. J. Dongarra, Argonne National Laboratory.


SPONSOR: SIAM Activity Group on Supercomputing.
ORGANIZER: J. J. Dongarra, Argonne National Laboratory.

January 1990

17-20. AMS-MAA Mathematics Meetings, Louisville, Kentucky. (April 1987, p. 553)
INFORMATION: H. Daly, American Mathematical Society, Meetings Department, Post Office Box 6248, Providence, Rhode Island 02940.

March 1990

ORGANIZERS: B. Matkowski, Northwestern University, and J. McKenna, AT & T Bell Laboratories.

May 1990

INFORMATION: C. F. Chen, Department of Aerospace and Mechanical Engineering, University of Arizona, Tucson, Arizona 85721. (For further details, see the News and Announcements section of this issue of Notices.)

June 1990

6-12. 1990 Barcelona Conference on Algebraic Topology, Centre de Recerca Matematica, Barcelona, Spain. (September 1988, p. 1060)

July 1990

ORGANIZER: A. Manitius, George Mason University.

August 1990

8-11. 93rd Summer Meeting of the AMS, Ohio State University, Columbus, Ohio.
INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

INFORMATION: ICM-90 Secretariat, Research Institute for Mathematical Sciences, Kyoto University, Kitashirakawa, Sakyoku, Kyoto 606, Japan. (For further information, see the News and Announcements section of the April 1988 issue of Notices.)

January 1991

INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

July 1991


August 1991

8-11. 94th Summer Meeting of the AMS, University of Maine, Orono, Maine.
INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

19-22. 1991 Joint Statistical Meetings, Atlanta, Georgia. (March 1988, p. 466)

January 1992

8-11. 98th Annual Meeting of the AMS, Baltimore, Maryland.
INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.

January 1994

5-8. 100th Annual Meeting of the AMS, Cincinnati, Ohio.
INFORMATION: H. Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940.
New AMS Publications

REGULAR DIFFERENTIAL FORMS
Ernst Kunz and Rolf Waldi
(Contemporary Mathematics, Volume 79)

This book is aimed at students and researchers in commutative algebra, algebraic geometry, and neighboring disciplines. The book will provide readers with new insight into differential forms, and may stimulate new research through the many open questions it raises.

The authors introduce various sheaves of differential forms for equidimensional morphisms of finite type between noetherian schemes, the most important being the sheaf of regular differential forms. It is known in many cases that the top degree regular differentials form a dualizing sheaf in the sense of duality theory. All constructions in the book are purely local and require only prerequisites from the theory of commutative noetherian rings and their Kahler differentials. The authors study the relations between the sheaves under consideration and give some applications to local properties of morphisms. The investigation of the "fundamental class," a canonical homorphism from Kahler to regular differential forms, is a major topic. The book closes with applications to curve singularities.

While regular differential forms have been previously studied mainly in the "absolute case" (that is, for algebraic varieties over fields), this book deals with the relative situation. Moreover, the authors strive to avoid "separability assumptions." Once the construction of regular differential forms is given, many results can be transferred from the absolute to the relative case.

Contents

Integral differential forms
Ideals in noetherian rings having a prime basis
Regular differential forms
Complementary modules
The fundamental class
Applications to curve singularities

1980 Mathematics Subject Classifications: 13B99, 14B05, 14F10
ISBN 0-8218-5085-7, LC 88-28825
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Institutional member $16
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ELEVEN PAPERS TRANSLATED FROM THE RUSSIAN
(American Mathematical Society Translations, Series 2, Volume 140)

This volume contains papers that range over a variety of topics, including information science, Lie algebras, group theory, category theory, functions of a complex variable, optimization, matrix theory, and number theory.

Contents

D. P. Skvortsov, On the question of "how many": Definition of the notion of cardinality of finite sets in some arithmetic systems
V. I. Bernik, Application of Hausdorff dimension in the theory of Diophantine approximations
L. A. Gutnik, On the irrationality of some quantities containing $\zeta(3)$
N. A. Dmitriev and E. B. Dynkin, Characteristic roots of stochastic matrices
F. I. Karpelevich, On the characteristic roots of matrices with nonnegative elements
Yu. P. Razmyslov, Finite basis property for the representations of a simple three-dimensional Lie algebra over a field of characteristic zero
L. G. Kiseleva, On the number of nontrivial solutions of homogeneous equations in words with three unknowns
L. A. Skornyakov, On the representation of monoids by multivalued mappings
A. F. Leont'ev, Representation of functions in convex domains by generalized exponential series
Yu. I. Manin, Remarks on algebraic supermanifolds

Use the order form in the back of this issue or call 800-556-7774 to use VISA or MasterCard.
Shipping and handling charges will be added.
K.-H. Elster and R. Heine, *On some connections between vector optimization and geometric optimization and their economic applications*

1980 Mathematics Subject Classifications: 03C62, 11J69, 11J72, 14A20, 15A18, 15A48, 15A51, 16A38, 17B60, 18B10, 20M05, 30B50, 32L25, 58A50, 90A05, 90C31; 03C10, 11M06, 19M30, 20M50, 22C10, 30C15, 68P20, 81E13


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ASSISTANTSHIPS AND GRADUATE FELLOWSHIPS IN THE MATHEMATICAL SCIENCES, 1989–1990

This new publication is an indispensable source of information for students seeking support for graduate work in the mathematical sciences. Because it provides data about a broad range of academic institutions, it is also a valuable resource for mathematical sciences departments and faculty.

Assistantships and Graduate Fellowships brings together a wealth of information about graduate assistantships and fellowships in mathematical sciences departments in the United States and Canada. (This information formerly appeared in the December issue of Notices of the AMS.) For each department listed, it provides the number of faculty, graduate students, and degrees awarded (BAs, MAs, and PhDs). Stipend amounts and the number of awards available are given, as well as information about foreign language requirements for the mathematics PhD and whether or not the department accepts critical, expository, or historical theses for the doctoral degree. There are also numerous display advertisements from mathematical sciences departments all over the country which expand upon the statistics that appear in the listings.

In addition, this publication lists sources of support for graduate study and travel, summer internships, graduate study in the U.S. for foreign nationals. Finally, a list of reference publications for fellowship information makes Assistantships and Graduate Fellowships a centralized and comprehensive resource.

1980 Mathematics Subject Classification: 00

ISBN 0-8218-0126-0

96 pages (softcover), December 1988

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FRENCH MATHEMATICAL SEMINARS
Nancy D. Anderson

The purpose of this new edition of the union list of French mathematical seminars is to provide a means for librarians to verify the existence of published French language séminaires. Intended for mathematics librarians rather than mathematicians, the list allows librarians to ascertain if a séminaire has been published, which library has it, and the forms of entry under which it has been cataloged. The bibliographic information provided here is intended to facilitate the acquisition, borrowing, and cataloging of these materials.

The current edition, almost double in size from the 1978 edition, provides information about 95 new seminars with numerous cross-references and increases the listing of exposés from individual seminars. In addition, entries from the first edition have been revised, corrected, and augmented.

1980 Mathematics Subject Classification: 00

ISBN 0-8218-0129-5, LC 88-29274

200 pages (softcover), 1978; second edition November 1988

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Reports of Past Meetings

1988 Summer Institute on Operator Theory/Operator Algebras and Applications

The American Mathematical Society held its thirty-sixth Summer Research Institute at the University of New Hampshire, Durham, New Hampshire, from July 3 - 23, 1988. The Institute was supported by Grant No. DMS-8714162 from the National Science Foundation.

This topic was selected by the 1986 Committee on Summer Institutes and Special Symposium whose members were ALBERT BAERNSTEIN II, ERIC FRIEDLANDER, H. BLAINE LAWSON, JR., LINDA PREISS ROTHSCHILD, ROBERT B. WARFIELD, JR. and JOHN WERMER.

Organizing Committee: Members of the Organizing Committee included: WILLIAM B. ARVESON, University of California, Berkeley (co-chair), RONALD G. DOUGLAS, SUNY at Stony Brook (co-chair), CIPRIAN I. FOIAS, Indiana University, I. C. GOHBERG, Tel Aviv University, PETER D. LAX, Courant Institute of Mathematical Sciences, DONALD SARASON, University of California, Berkeley, BARRY SIMON, California Institute of Technology, and DAN-VIRGIL VOICULESCU, University of California, Berkeley.

Program: The institute was devoted to the presentation and extension of research on the topic of operator theory and operator algebras and the variety of areas in both pure and applied mathematics in which they play an important role. The program consisted of thirty (30) ninety-minute expository lectures, twenty (20) sixty-minute expository lectures and and eighty-three (83) thirty-minute research reports presented at afternoon seminar sessions.

Lecture Notes: Forty-three (43) papers were reproduced and distributed to participants during the Institute, totaling 765 pages.

Participants: There were 228 registered mathematicians, 27 of which were students. Accompanying members included 27* spouses and 18 children. Of all registered, the length of attendance at the Institute was:

- Less than one week: 8 3.5%
- One week: 132 58.0%
- Two weeks: 39 17.0%
- Three weeks: 49 21.5%

*Includes three spouses that were registered participants.

Twenty-three countries in addition to the United States were represented by the following numbers of participants: Argentina (2), Australia (2), Canada (18), Colombia (1), China (2), Denmark (4), England (6), France (3), Hong Kong (1), W. Germany (7), Guyana (1), Israel (4), Italy (1), Japan (2), the Netherlands (1), Norway (3), Poland (1), Scotland (1), South Africa (1), Taiwan (4), Uruguay (1), USSR (2) and Yugoslavia (1).

NSF grant support was awarded to 153 mathematicians which represents 67% of the total of registered participants. To maximize the number of participants receiving travel and/or subsistence reimbursement, partial support was offered in most cases.

Conclusion: The organizing committee did an outstanding job in arranging for a scientific program that was intense, significant and challenging for the participants. The quality of lectures and research presented was exemplary.

The Centennial Celebration in Providence

The Centennial Celebration of the AMS, the 91st summer meeting of the Society, was held August 8-12, 1988 in Providence, Rhode Island. Included were the 67th Summer Meeting of the Mathematical Association of America, 1987 Annual Meeting of Pi Mu Epsilon, and the 1987 Annual Meeting of the Association for Women in Mathematics. Scientific sessions took place in the Providence Performing Arts Center, the Omni Biltmore Hotel, Brown University, and the Rhode Island School of Design. There were 1638 registrants, including 1107 members of the Society.

AMS-MAA Invited Addresses.

By invitation of the AMS-MAA Joint Program Committee (Hugh L. Montgomery (Chairman), M. Susan Montgomery, Ivan Niven, and Richard S. Palais), three speakers presented lectures on the history and development of mathematics: Raoul H. Bott, Harvard University, The topological constraints on analysis; Peter D. Lax, Courant Institute of Mathematical Sciences, New York University, The flowering of applied mathematics in America; Saunders Mac Lane, University of Chicago, Some major research departments of
Mathematics. The three speakers were introduced by Andrew M. Gleason, George Daniel Mostow, and Leonard Gillman, respectively.

Mathematics Into the Twenty-first Century. This special symposium featured a series of 18 speakers invited by the Centennial Program Committee (Hyman Bass, Felix E. Browder (Chairman), Phillip A. Griffiths, John W. Milnor, Cathleen S. Morawetz). The speakers’ names, affiliations, and lecture titles are:

- Michael Aschbacher, California Institute of Technology, Representations of finite groups as permutation groups, introduced by Daniel Gorenstein.
- Persi Diaconis, Harvard University, Sufficiency as statistical symmetry, introduced by Gian-Carlo Rota.
- Charles L. Fefferman, Princeton University, Problems from mathematical physics, introduced by Felix E. Browder.
- Michael H. Freedman, University of California, San Diego, Working and playing with the two-dimensional disk, introduced by William Browder.
- Harvey M. Friedman, Ohio State University, The incompleteness phenomena, introduced by Saunders Mac Lane.
- Benedict H. Gross, Harvard University, Modular forms and elliptic curves, introduced by John T. Tate.

Joseph Harris, Harvard University, Developments in algebraic geometry, introduced by Phillip A. Griffiths.
- Roger E. Howe, Yale University, A century of Lie theory, introduced by George Mackey.
- Vaughan F. R. Jones, University of California, Berkeley, A von Neumann algebra excursion: From quantum theory to knot theory and back, introduced by Joan S. Birman.
- Victor G. Kac, Massachusetts Institute of Technology, Modular invariance in mathematics and physics, introduced by Nathan Jacobson.
- Andrew J. Majda, Princeton University, Mathematical fluid dynamics: The interaction of nonlinear analysis and modern applied mathematics, introduced by Peter D. Lax.
- Charles S. Peskin, Courant Institute of Mathematical Sciences, New York University, Mathematics and computing in physiology and medicine: Examples from the past, present, and future, introduced by Cathleen S. Morawetz.
- Dennis P. Sullivan, Graduate School and University Center, City University of New York, Progress on the renormalization conjectures in dynamical systems, introduced by Stephen Smale.
- Robert E. Tarjan, Princeton University and AT&T Bell Laboratories, Mathematics in computer science, introduced by Ronald L. Graham.
- William P. Thurston, Princeton University, Three-dimensional geometry and topology, introduced by Lipman Bers.

Karen K. Uhlenbeck, University of Texas at Austin, Instantons and their relatives, introduced by Shing S. Chern.

Edward Witten, Institute for Advanced Study, Quantum field theory and Donaldson Polynomials, introduced by Clifford Taubes.

Special Sessions. There were no Special Sessions at the Centennial Celebration.


Other Activities. Special events to commemorate the AMS Centennial included the Opening Ceremonies, held at the Providence Performing Arts Center, and the Opening Reception, held at the Rhode Island State House. The Society’s Committee on Membership hosted a special reception at the Providence City Hall for those members who had attended the Semicentennial Celebration in 1938.
Personal Items

Vladimir Igorevich Arnol'd, of Moscow University, has been elected a foreign member of the United Kingdom’s Royal Society.

Sir Michael Atiyah, of the University of Oxford, was awarded the 1988 Copley Medal by the United Kingdom’s Royal Society. The medal was presented in recognition of his contributions to geometry, topology, analysis, and theoretical physics.

C. Y. Chan, Professor and Graduate Coordinator of Mathematics at the University of Southwestern Louisiana, has been given the Distinguished Professor Award for 1988 by the University of Southwestern Louisiana Foundation.

Victor G. Feser, of the University of Mary, Bismarck, North Dakota, has been promoted to Professor of Mathematics at that institution, effective August 1988.

Simon A. Levin, of Cornell University, was awarded the 1988 MacArthur Award for 1988.

Leopoldo Nachbin, George Eastman Professor, University of Rochester, was elected a Corresponding Member of the Academia Nacional de Ciencias Exactas, Fisicas y Naturales, Argentina.

Edward A. Saibel, of Durham, North Carolina, has been named an Honorary Member of the American Society of Engineers (ASME).

C. T. C. Wall, of the University of Liverpool, was awarded the 1988 Sylvester Medal by the United Kingdom’s Royal Society.

The medal was presented in recognition of his contributions to the topology of manifolds and related topics in algebra and geometry.

E. C. Zeeman, of the University of Warwick, was awarded the 1988 Michael Faraday Award by the United Kingdom’s Royal Society. The award was made in recognition of his work in furthering the public understanding of science and mathematics through his lectures, writing, and media appearances.

Deaths

Raouf Doss, Professor Emeritus of the State University of New York at Stony Brook, died on September 8, 1988, at the age of 72. He was a member of the Society for 38 years.

Walter Leighton, Professor Emeritus of the University of Missouri, Columbia, died on August 27, 1988, at the age of 80. He was a member of the Society for 52 years.

Rothwell Stephens, of Norman, Oklahoma, died on August 16, 1988, at the age of 81. He was a member of the Society for 57 years.

Louis Weisner, Professor Emeritus of the University of New Brunswick, Canada, died on June 27, 1988, at the age of 89. He was a member of the Society for 66 years.

Joseph Wright, of Yonkers, New York, died on September 23, 1987, at the age of 73. He was a member of the Society for 17 years.

Visiting Mathematicians (Supplementary List)

Mathematicians visiting other institutions during the 1987-1988 academic year have been listed in recent issues of Notices:

- June 1987, pages 696-698
- August 1987, page 824
- October 1987, pages 1008-1009
- November 1987, pages 1149-1150
- January 1988, page 171
- May/June 1988, pages 747-749
- July/August 1988, pages 914-915
- September 1988, pages 1080-1081
- October 1988, page 1261

- Kenneth A. Brown (Scotland), University of Washington, March 1989 to July 1989, ring theory.
- Rolando Cavazos-Cadena (Mexico), Texas Tech University, September 1988 to May 1989, Markov-decision Processes.
- Daizan Chang (People’s Republic of China), Texas Tech University, September 1988 to May 1989, control theory.
- Bernard Coupet (France), University of Washington, March 1989 to July 1989, several complex variables.
- M. Lucia Fania (Italy), University of Notre Dame, August 1988 to May 1989, algebraic geometry.
- John Jayne (England), University of Washington, September
GLOBAL ANALYSIS
1980-86

Introduction by Anthony J. Tromba

The term "global analysis" refers to the general area of analysis on manifolds, in which the methods of modern algebra, analysis, geometry, and topology are blended. Although the beginnings of these ideas can be traced to the 17th century, major contributions in this direction were made by Lie, Riemann, and Poincaré toward the end of the last century, followed by the work of G. D. Birkhoff, E. Cartan, and Morse in the early part of this century. However, it is only in recent years that the subject has attained its present central position in mathematics. The subject has many rich applications to fields outside mathematics—such as mechanics, quantum physics, and general relativity—as well as within mathematics itself.

Today, this vital and active field is undergoing a virtual explosion of new and important results. Reviews in Global Analysis makes information about the most recent contributions to this rapidly growing field accessible both to specialists working in global analysis, and to those in other areas of pure and applied mathematics.

These five volumes contain the more than 18,000 reviews that appeared in Mathematical Reviews from 1980 through 1986 and have a primary or a secondary classification in Global Analysis (classification number 58). Relevant cross-references are provided with each review. The fifth volume of this set contains author and key indexes, making it very easy to locate items written by a specific author or to get information about collections or conference proceedings dealing with global analysis.

Contents:
Volume 1: Global analysis, analysis on manifolds; General theory of differentiable manifolds; Infinite-dimensional manifolds; Calculus on manifolds; Nonlinear operators; Spaces and manifolds of mappings;
Volume 2: Variational problems in infinite-dimensional spaces; Ordinary differential equations on manifolds; Dynamical systems;
Volume 3: Ordinary differential equations on manifolds; Dynamical systems;
Volume 4: Partial differential equations on manifolds; Differential operators; Pseudogroups and general structures on manifolds;
Volume 5: Series contents; Author index; Key index.

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Application Deadlines for Grants and Assistantships

Many fellowship programs have deadlines for receipt of applications. These deadlines are noted in news items and in the Stipends Section of the December Notices. They are listed below for your convenience, and as a reminder since many of these deadlines occur before the publication date of the December issue. Dates taken from the December 1987 issue have been updated with information received in preparation for the December 1988 issue. For information about the various programs the reader is referred to the appropriate part of the Stipends Section of the December 1987 Notices as follows: [GS] = Graduate Support Section; [PS] = Postdoctoral Support Section; [TSA] = Travel and Study Abroad Section; [SFN] = Study in the U.S. for Foreign Nationals.

* Information from the December 1987 issue not yet confirmed this year.
• Refers to a news item in this issue of Notices.

October 1
American Philosophical Society [PS]
Bunting Institute of Radcliffe College (Science Scholar Fellowships) [PS]
John Simon Guggenheim Memorial Foundation Fellowships [PS]

October 19
Kennedy Scholarships [SFN]

November 1
American-Scandinavian Foundation [TSA]
Fannie and John Hertz Foundation Fellowships [GS]
University of Michigan (Michigan Society of Fellows Postdoctoral Fellowships) [PS]

November 5
North Atlantic Treaty Organization (Postdoctoral Fellowships) [TSA]

November 14
National Research Foundation (Ford Foundation Predoctoral and Dissertation Fellowships for Minorities) [GS]
NSF Graduate Fellowships [GS]
NSF Minority Graduate Fellowships [GS]

November 15
AAUW Educational Foundation American Fellowships [PS]
Committee on Scholarly Communication with the People's Republic of China (CSCPRC) [TSA]
Kosciuszko Foundation [SFN]
* Los Alamos National Laboratory (J. Robert Oppenheimer Research Fellowship) [PS]
NSF Mathematical Sciences Postdoctoral Research Fellowships [PS]
NSF Visiting Professorships for Women [GS]
Royal Norwegian Council for Scientific and Industrial Research (Postdoctorate Fellowships) [TSA]

November 30
North Atlantic Treaty Organization [TSA]

December 1
AMS Centennial Research Fellowships [PS]
American Philosophical Society [PS]
Argonne National Laboratory (James H. Wilkinson Fellowship) [GS]
Lady Davis Fellowship Trust [TSA]
Lady Davis Visiting Professorships [TSA]
Sigma Delta Epsilon, Graduate Women in Science (Eloise Gerry Fellowship) [GS]

December 15
IBM Thomas J. Watson Research Center (Postdoctoral Fellowships for Research in Mathematical Sciences) [PS]
Mathematical Sciences Research Institute [PS]

December 31
* Institute for Advanced Study Memberships [PS]
* Massachusetts Institute of Technology (C.L.E. Moore Instructorships in Mathematics) [PS]
University of Utah (Instructorship in Mathematics) [PS]
University of Wisconsin, Madison (Van Vleck Assistant Professorship in Mathematics) [PS]

January 1
Brown University (Jacob David Tamarkin Assistant Professorships) [PS]
California Institute of Technology (Harry Bateman Research Instructorships) [PS]
* Courant Institute (Instructorships in Mathematics) [PS]
* Courant Institute (Postdoctoral Visiting Memberships) [PS]
Application Deadlines

Harvard University (Benjamin Peirce Lectureships) [PS]
Indiana University, Bloomington (Václav Hlavatý Research Assistant Professorships) [PS]
University of California, Los Angeles (Earle Raymond Hedrick Assistant Professorships in Mathematics) [PS]
University of Chicago (Leonard Eugene Dickson Instructorships in Mathematics) [PS]
University of Pennsylvania (Hans Rademacher Instructorship) [PS]
University of Texas (R. H. Bing Faculty Fellowships) [PS]
Weizmann Institute of Sciences (Feinberg Graduate School Postdoctoral Fellowships [TSA]
Weizmann Institute of Sciences (Openings for Scientists) [TSA]
Yale University (Josiah Willard Gibbs Instructorships) [PS]

January 6
Committee on Institutional Cooperation (Minorities Fellowships in the Sciences, Mathematics and Engineering) [GS]
University of California, San Diego (S. E. Warschawski Assistant Professorships) [PS]
University of Michigan, Ann Arbor (T. H. Hildebrandt Research Assistant Professorships) [PS]

January 13
National Center for Atmospheric Research (Advanced Study Program) [PS]
National Research Council (Postdoctoral Fellowships for Minorities) [PS]

January 15
AAAS Science, Engineering and Diplomacy Fellowships [PS]
Dartmouth College (John Wesley Young Research Instructorships) [PS]
Institute for Mathematics and its Applications [PS]
Kosciuszko Foundation [GS]
Kosciuszko Foundation (Graduate and Postgraduate Exchange with Poland) [TSA]
* National Research Council (Research Associateship Programs) [PS]
Purdue University (Research Assistant Professorships) [PS]
Rice University (Griffith Conrad Evans Instructorships) [PS]
Rutgers University (Hill Assistant Professorships) [PS]
* University of Pittsburgh (Andrew Mellon Postdoctoral Fellowships) [PS]

January 16
Fulbright Program (Collaborative Research Grants) [TSA]

January 30
* Centro de Investigacion del IPN (Solomon Lefschetz Research Instructorships) [TSA]

January 31
* Yale University (Josiah Willard Gibbs Instructorships) [PS]

February 1
AAAS Summer Fellowship [GS]
American Philosophical Society [PS]
* American Society for Engineering Education (NASA-ASEE Summer Faculty Fellowships) [PS]
* American Society for Engineering Education (Navy- and DOE-ASEE Summer Faculty Research Programs) [PS]
* American Society for Engineering Education (ONR Graduate Fellowship Program [GS]
Sigma Delta Epsilon, Graduate Women in Science (Grants-in-Aid) [GS]
University of Cincinnati (Charles Phelps Taft Postdoctoral Fellowships) [PS]

February 11
* California State Graduate Fellowships [GS]

February 28
Australian Institute of Nuclear Science and Engineering (Research Fellowships) [PS]

March 15
Hubert H. Humphrey Doctoral Fellowships [GS]

March 31
North Atlantic Treaty Organization [TSA]

April 1
American Philosophical Society [PS]

April 15
National Research Council (Research Associateship Programs) [PS]

May 15
Weizmann Institute of Sciences (Feinberg Graduate School Postdoctoral Fellowships [TSA]
Weizmann Institute of Sciences (Openings for Scientists) [TSA]

June 15
Indo-American Fellowship Program [TSA]

August 1
American Philosophical Society [PS]

August 15
National Research Council (Research Associateship Programs) [PS]
North Atlantic Treaty Organization [TSA]

August 31
Australian Institute of Nuclear Science and Engineering (Research Fellowships) [PS]
## New Members of the AMS

### ORDINARY MEMBERS

<table>
<thead>
<tr>
<th>Name</th>
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### Reciprocity Members

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- Jolanta Misiewicz
A Century of Mathematics in America — Part I

Peter L. Duren, Editor
with the assistance of Richard A. Askey and Uta C. Merzbach

In the 100 years since the founding of the AMS, the American mathematical community has grown from a small group heavily dependent on European mathematicians to a large and influential group that in many areas sets the standard for the rest of the world. By the 1930s, there was a flourishing mathematical community to welcome the influx of mathematicians fleeing Europe. These refugees supplied additional strength and new vigor to a field that increased dramatically as a result of World War II and the postwar recognition of mathematics. This volume, the first in the new History of Mathematics series, brings together a variety of perspectives on the political, social, and mathematical forces that have shaped the American mathematical community in the past century. Humorous, edifying, and poignant, this book presents the personal recollections of a number of mathematicians who have influenced the development of mathematics in this country.

One of the highlights of the volume is Lipman Bers’s paper which was presented as an AMS-MAA Joint Invited Address in Atlanta in January 1988 and which gives a moving account of the reception that he and other European refugee mathematicians received in this country. Described here are some of the success stories of this century—such as classification of finite simple groups, delineated by Daniel Gorenstein—as well as some of the problems—such as the McCarthy period, chronicled by Chandler Davis. Paul R. Halmos, one of the most influential textbook writers, tells of the textbooks he used when he was a student and young professor and how they influenced him. Among the papers reprinted here are some that have appeared in journals not ordinarily read by mathematicians, such as the article by science historian Nathan Reingold, which appeared in The Annals of Science.

Mathematicians, historians of science, and students alike will find this book illuminating and rewarding. That the lessons of the past can guide the resolution of present problems makes this book important reading for all who are concerned with the development of mathematics. It will also make a fine addition to any library collection.

1980 Mathematics Subject Classification: 01 ISBN 0-8218-0124-4, LC 88-22155 ISSN 0899-2428 486 pages (hardcover), August 1988 List price $57, Institutional member $46, Individual member $34 To order, please specify HMATH/1NA

Shipping/Handling: 1st book $2, each add’l $1, $25 max. By air, 1st book $5, each add’l $3, $100 max. Prepayment required. Order from AMS, P. O. Box 1571, Annex Station, Providence, RI 02901-1571, or call 800-556-7774 to use VISA or MasterCard.
The Department of Mathematics is actively seeking applications in the area of computational mathematics and numerical analysis. We anticipate making several tenure-track appointments at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Applications will be reviewed as they are received and will be accepted until the positions are filled. A formal letter of application expressing interest, a resume, and the names, addresses, and telephone numbers of three references should be sent to Chairman, Numerical Analysis Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

FLORIDA STATE UNIVERSITY, MATHEMATICS DEPARTMENT, TALLAHASSEE, FLORIDA 32306-3027 We anticipate filling two tenure-track assistant professorships, with appointments beginning August, 1989. Well qualified candidates in all areas of pure or applied mathematics are encouraged to apply. Candidates should have excellent research programs and excellent teaching ability. Salary is competitive. Please send resume and arrange to have three letters of recommendation sent to Ralph D. McWilliams, Chairman. Application deadline is January 13, 1989. Florida State University is an EEO/AA employer.
DUKE UNIVERSITY
Department of Computer Science

The Duke University Department of Computer Science is recruiting junior faculty in theoretical computer science and in biomedical scientific computing. Applicants must demonstrate excellence in research or exhibit the promise of excellence.

The Department currently has seventeen tenure track faculty, approximately 200 undergraduate majors and 70 graduate students pursuing master’s and/or doctoral degrees.

The Department has major research efforts in scientific computing with emphasis on numerical linear algebra, the solution of PDEs, and VLSI simulation; computer systems with emphasis on computer architectures, modeling of fault-tolerant systems, systems performance, and communications; artificial intelligence, particularly in the areas of natural language interface, search methodologies, and expert systems; and theory and algorithms with emphasis on combinatorial and graph-theoretic studies. Special motivation for the research efforts comes from the areas of medical applications (in collaboration with the Duke Medical Center), and VLSI (in collaboration with the Microelectronics Center of North Carolina, of which Duke is a Participating Institution).

Interested applicants should send copies of their resumes and other supporting material by February 14, 1989, to:

Professor Donald J. Rose
Department of Computer Science
Duke University
Durham, NC 27706

Duke University is an affirmative action, equal opportunity employer.

UNIVERSITY OF NEW MEXICO
Albuquerque, New Mexico
Department of Mathematics and Statistics

The Department expects to have four tenure track positions available beginning Fall Semester, 1989. We are particularly interested in candidates at the assistant professor level, but we will consider outstanding applicants at all levels. Candidates must have a strong research record or outstanding potential and a commitment to excellence in teaching.

Preference will be given to applicants with research interests related to strengths in the department, including: areas in analysis, computational mathematics, discrete mathematics, geometry, nonlinear systems, mathematical biology, mathematical physics, probability and statistics.

The Department of Mathematics and Statistics currently has 45 faculty members and an active and expanding graduate program. The department has close research ties with Los Alamos and Sandia National Laboratories, access to outstanding computing facilities and is currently developing an Applied Mathematics and Statistics Consulting Laboratory.

Review of applications will begin January 15, 1989, and will continue until the positions are filled. All strong candidates, especially women and minority group members, are urged to apply. Please have vitae and three letters of reference sent to:

Professor Carla Wofsy
Hiring Committee
Department of Mathematics and Statistics
University of New Mexico
Albuquerque, New Mexico 87131

THE UNIVERSITY OF NEW MEXICO IS AN AA/EOE.

Southern Methodist University
Department of Mathematics

The Department of Mathematics at Southern Methodist University seeks applications for one senior and several junior tenure track positions with employment beginning Fall, 1989. Candidates should be active researchers in applied mathematics and should have a strong commitment to undergraduate teaching. Preference will be given to applicants who can contribute to the doctoral program in applied mathematics, numerical analysis and scientific computation. For the senior position, candidates should have an outstanding research record and experience in advising Ph.D. students. The teaching load for each position is two courses (six hours) per semester. There may also be visiting positions available in academic year 1989-90.

The Mathematics Department has a strong and ongoing commitment to the development of classical and modern applied mathematics. Current areas of research of our 11 applied mathematicians include mathematical modeling of physical and biological phenomena, nonlinear waves, perturbation methods, parameter estimation, numerical bifurcation, mathematical software for differential equations and parallel computation. Candidates should be active in one of these areas or a related one. Among its computers, the university has a Sequent Symmetry for research use.

Applications must be received by January 1, 1989. Please send a vita and three letters of recommendation to: I. Gladwell, Chairman, Department of Mathematics, Southern Methodist University, Dallas, Texas 75275 (Tel: (214) 692-2506).

SMU is an equal opportunity/affirmative action/Title IX employer.
The Department of Mathematics at Boston University anticipates an opening at the assistant professor level or above beginning in the fall of 1989. A Ph.D. is required. Very strong research potential required for junior-level appointments and demonstrated outstanding record for senior-level appointments. Applications will be accepted until March 15, 1989, or until the positions are filled. Applicants should send vita and three letters of reference to: Chairman, Search Committee, Department of Mathematics, Virginia Tech, Blacksburg, VA 24061-0123. Virginia Tech is an Equal Opportunity/Affirmative Action Employer.

CARNEGIE MELLON UNIVERSITY
Department of Mathematics

The Department of Mathematics at Carnegie Mellon University anticipates an opening at the level of full Professor. Applications are invited from mathematicians and applied mathematicians with exceptionally strong accomplishments in research and considerable experience in teaching. Candidates' research interests should overlap significantly with those of Department members. Applications should be sent to: Senior Appointments Committee, Department of Mathematics, Carnegie Mellon University, Pittsburgh, PA 15213. Carnegie Mellon University is an Affirmative Action/Equal Opportunity Employer.

The University of Georgia
Department of Mathematics
Athens, GA 30602

Applications are invited for a three-year POSTDOCTORAL RESEARCH POSITION in the Department of Mathematics beginning in the fall of 1989. The salary for the academic year 1989-90 will be $31,500. No teaching duties are required. Applicants must show very strong promise in research. Send curriculum vitae and four letters of recommendation to Ray A. Kunze, Head (address above) by January 5, 1989. UGA is an Equal Opportunity/Affirmative Action Employer.
**Classified Advertisements**

**POSITIONS AVAILABLE**

**NEW SENIOR FACULTY**

**in COGNITIVE AND NEURAL SYSTEMS**

**at BOSTON UNIVERSITY**

Boston University seeks a full professor or associate professor starting in Fall, 1989, to act as Co-Director for its M.A. and Ph.D. Program in Cognitive and Neural Systems. The Co-Director will play a major role in curriculum development, administration, and training of mathematically advanced graduate students. The program curriculum offers the full range of psychological, neurobiological, and computational concepts, models, and methods in the broad field variously called neural networks, connectionism, parallel distributed processing, and biological information processing, in which Boston University is a leader. The faculty member will have a joint appointment in the Ph.D. program and in one or more of the departments of mathematics, biology, computer science, and psychology. Candidates should have extensive analytic and computational research experience and an international reputation for modelling a broad range of real-time nonlinear neural networks, enabling them to teach graduate courses including the areas of adaptive pattern recognition and self-organization. Send a complete curriculum vitae and at least three letters of recommendation to Search Committee, Cognitive and Neural Systems Program, Room 240, 111 Cummington Street, Boston University, Boston, MA 02215, preferably by November 15, 1988, but no later than January 1, 1989. Boston University is an Equal Opportunity/Affirmative Action employer.

**UNIV. OF N.C. AT CHAPEL HILL,**

**DEPT. OF MATHEMATICS,**

**CHAPEL HILL, N.C. 27514**

Applications are invited for a senior level tenured appointment in the general area of applied and computational mathematics, effective Fall, 1989. Rank and salary depend on qualifications. A Ph.D. and demonstrated excellence in research and teaching are required. Applications will be accepted until the position is filled; however, applications received by January 15, 1989, are assured of full consideration. Send 4 letters of recommendation, vitae, and abstracts of current research to Search Committee, Pat Levin, Mathematics Department, Box 3250 Phillips Hall, UNC at Chapel Hill, Chapel Hill, NC 27599. EO/AA Employer. Women and minorities are encouraged to identify themselves voluntarily.

Mathematics Department  
California State University  
Northridge, California 91330  

One tenure track position is available. Requirements are a Ph.D. in Mathematics, evidence of teaching excellence, and research activity in applied mathematics. Applications will be considered for appointment at the assistant professor rank. Salary range: $30,252 to $36,408.

Starting date for this position is August 29, 1989. Send a cover letter and resume by December 19, 1988, to Dr. D. H. Potts, Chair, Department of Mathematics, California State University, Northridge, California 91330.

California State University is an Equal Opportunity, Affirmative-Action, Handicapped Title IX Employer.

**DEPARTMENT OF MATHEMATICS AND STATISTICS**

**UNIVERSITY OF NEBRASKA-LINCOLN**

**LINCOLN, NE 68588-0323**

Tenure-track position in statistics at the Associate Professor or beginning Full Professor level beginning Fall, 1989. Ph.D. required with excellent teaching skills and strong research credentials along with a commitment to strengthen the existing Ph.D. program. Send vita and three letters of recommendation to Prof. K. M. Saxena, Statistics Search Committee Chair, Department of Mathematics and Statistics, University of Nebraska-Lincoln, Lincoln, NE 68588-0323. AA/EOE. Deadline February 1, 1989, or until position filled. Women and minorities are especially encouraged to apply. 402-472-7242

**WILLIAMS COLLEGE**

**DEPARTMENT OF MATHEMATICS**

**WILLIAMSTOWN, MASSACHUSETTS 01267**

We anticipate three positions, probably at the rank of assistant professor, for Fall, 1989. For one position, there is a preference for statistics or operations research.

Strong commitment to both teaching and scholarship is essential. The teaching load is five 1-semester courses per year, plus a "Winter Study", in alternate Januaries, beginning in the second year.

Please send a vita and three letters of recommendation on teaching and research to Frank Morgan, Chair. Evaluation of applications will begin November 15 and continue until positions are filled. Since Williams is an affirmative action/equal opportunity employer, we encourage applications from women and minorities.
DEPARTMENT OF STATISTICS
UNIVERSITY OF CALIFORNIA
AT BERKELEY

Pending final budgetary approval, we invite applications for a faculty position at any tenured or tenure-track rank, to begin July 1, 1989. We will consider strong candidates in any area of theoretical and applied statistics, computer-intensive statistics, probability and applied probability theory.

Interdisciplinary interests are encouraged and joint appointments are a possibility. Send inquiries and applications including a resume and three references by January 30, 1989, to:

P. W. Millar
Personnel Committee
Department of Statistics
University of California
Berkeley, CA 94720

The University of California is an Equal Opportunity/Affirmative Action Employer.

DIRECTOR, MATHEMATICAL SCIENCES DIVISION

The Office of Naval Research is seeking an outstanding individual to serve in this Civil Service position in the Senior Executive Service (SES). Salary range is $65,994 to $73,400, depending on qualifications. In addition to salary, career SES appointees are eligible to compete for performance awards and bonuses.

The Director, Mathematical Sciences Division supervises senior Scientific Officers plus support personnel and is responsible for providing leadership, direction, and coordination for the $18M Contract Research Program in mathematical sciences. Duties include program planning, program execution, assessment of program accomplishments, and exploitation of results in applications to Navy technology. Scientific and technical areas of concern include, but are not limited to, pure mathematics, applied mathematics, numerical analysis, statistics, probability, operations research and discrete mathematics. The Division Director is the scientific administrator of ONR R&D activity in the described fields with full responsibility for staffing his/her program, establishing overall priorities and procedures, and recommending changes in program objectives and policies to the Director, Mathematical and Physical Sciences Directorate. The Division Director serves as the principal consultant to the Navy on developing naval applications in mathematical sciences.

Candidates should possess a Ph.D. or equivalent in the area of mathematics and significant research accomplishments in one or more of the above disciplinary areas. Considerable experience in fiscal and program administration, plus management and performance of research and its application to development is also required.

Interested persons should submit a Standard Form 171, Application for Federal Employment (available at Federal Job Information Centers or from the address below) and a resume, including a list of publications, to:

OFFICE OF THE CHIEF OF NAVAL RESEARCH
Civilian Personnel Division, Code 01242P
Attn: Announcement #88-76 (AMS)
800 North Quincy Street
Arlington, VA 22217-5000

Applications will be accepted through 6 January 1989 and must be received by that date. Applicants are requested to complete the appropriate supplemental forms. For further information and supplemental forms, please call (202) 696-4705.

U.S. CITIZENSHIP REQUIRED • AN EQUAL OPPORTUNITY EMPLOYER

DEPARTMENT OF MATHEMATICAL SCIENCES
NORTHERN ILLINOIS UNIVERSITY

Several tenure-track positions in pure and applied mathematics beginning Fall, 1989. Applicants should have strong research record or potential and strong commitment to teaching. Mathematicians in any area of pure and applied mathematics may apply. Applicants should anticipate completion of the Ph.D. by August, 1989. Preference for research complementing that of present faculty. Salary range competitive. Research-oriented department, offers Ph.D. Two-course teaching load. Send vita and three letters of reference by January 17, 1989, to:

Dr. J. L. Selfridge, Chair
Department of Mathematical Sciences
Northern Illinois University
DeKalb, IL 60115-2888

Northern Illinois University is an Affirmative Action/Equal Opportunity Employer.

GOUCHER COLLEGE
MATHEMATICS AND COMPUTER SCIENCE DEPARTMENT

Applications are invited for at least one tenure track position at the Assistant or Associate Professor level beginning August, 1989. Qualifications include a Ph.D. in mathematics or computer science and a strong commitment to and demonstrated excellence in undergraduate teaching. Responsibilities include a teaching load of 9-10 hrs/wk and continuing scholarly activity. Goucher is a select, private, coeducational, liberal arts college located eight miles north of Baltimore and is convenient to Washington, D.C. The selection process will begin Jan., 1989. Goucher is an EOE. Send vita and three letters of recommendation to:

Dr. Joan S. Morrison
Chair of the Mathematics and Computer Science Department
Goucher College
Towson, MD 21204
Classified Advertisements

UNIVERSITY OF COLORADO AT COLORADO SPRINGS, DEPARTMENT OF MATHEMATICS, COLORADO SPRINGS, CO 80933-7150

Applications are invited for several tenure-track positions starting Fall 1989. Preferred areas: Algebra, Differential Equations, Harmonic Analysis, Probability and Statistics. However, candidates with research interests outside of these areas are also encouraged to apply. Applicants should have significant research accomplishments or exceptional research promise and evidence of good teaching ability. Ph.D. is required. Salary and rank are negotiable. The average weekly teaching load is 7 1/2 hours. There is generous support for faculty development like conference travel, teaching off-loads and summer research. Please arrange to send a resume and 3 letters of reference to Dr. K. M. Rangaswamy, Chairman. Initial screening will begin on December 1, 1988 and continue through March 1989 or until all positions are filled. UCCS is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF CALIFORNIA AT DAVIS, DEPARTMENT OF MATHEMATICS

Applications are invited for three or more anticipated tenure track positions in the Department of Mathematics, University of California, Davis, effective 7/1/89. Appointments will be made at rank and salary commensurate with qualifications. Qualifications include a Ph.D. and an outstanding record or great promise in teaching and mathematical research. We are particularly interested in applicants with a distinguished research record in Applied Analysis, Mathematical Physics, or Mathematical Biology, but outstanding candidates in other fields will be given full consideration. Postmarked deadline for applications is January 16, 1989. An application consists of a curriculum vitae, list of publications, and at least three letters of reference sent to: Chair of Search Committee, Department of Mathematics, University of California, Davis, CA 95616. The University of California is an Equal Opportunity/Affirmative Action Employer.

CANSIS COLLEGE
DEPARTMENT OF MATHEMATICS

A tenure track position (Assistant Professor) in mathematics is available in late August, 1989. Applicants must have a Ph.D. in mathematics and a strong commitment to quality teaching. The teaching load is twelve hours per semester. Salary and fringe benefits are competitive commensurate with credentials and experience.

Applicants should send resume, transcripts and three letters of recommendation to Dr. Richard H. Escobales, Chairman, Department of Mathematics, Canisius College, Buffalo, New York, 14208. AA/EEO.

DARTMOUTH COLLEGE
John Wesley Young
Research Instructorship

The John Wesley Young Research Instructorship is a two year post-doctoral appointment for promising new or recent Ph.D.'s whose research interests overlap a department member's. Current departmental interests include areas in algebra, analysis, algebraic geometry, combinatorics, computer science, differential geometry, logic and set theory, number theory, probability and topology. Teaching duties of four ten-week courses spread over two or three quarters typically include at least one course in the instructor's specialty and include elementary, advanced and (at instructor's option) graduate courses. Nine-month salary of $29,500 supplemented by summer (resident) research stipend of $6555 (two-ninths). Send letter of application, resume, graduate transcript, thesis abstract, description of other research activities and interests if appropriate, and 3 or preferably 4 letters of recommendation (at least one should discuss teaching) to Kenneth P. Bogart, Recruiting Committee Chair, Department of Math and CS, Bradley Hall, Hanover, NH, 03755. Applications received by Jan. 10 receive first consideration; applications will be accepted until position is filled. Dartmouth College is committed to affirmative action and strongly encourages applications from minorities and women.

UNIVERSITY OF WYOMING
Department of Mathematics

Invites applications for the following positions:

A senior-level position in the area of computational mathematics. Candidates should have an outstanding record of accomplishment in an area of computational applied mathematics that makes significant use of high speed computers. The appointee will be expected to interact with our Center for Computational Mathematics and Mechanics and to provide leadership in the developing field of scientific computation.

Send resume and direct three letters of recommendation to:
Professor W. Bridges, Chairman
Mathematics Department
P.O. Box 3036 University Station
University of Wyoming
Laramie, WY 82071-3036
(307) 766-4222

Applications completed by January 31, 1989, will be given first consideration. The University of Wyoming is an equal Opportunity/Affirmative Action Employer.

Possible tenure-track professor or associate professor positions to start August 21, 1989. We seek people who will strengthen our research program and interact with other members of the department. Applicants must have a distinguished research record, as evidenced by publications and grant support, and a strong commitment to teaching. Rank and salary will depend on experience and qualifications. Send vita and have three letters of reference sent to: Carol L. Walker, Head, Department of Mathematical Sciences, New Mexico State University, Las Cruces, NM 88003. An Equal Opportunity/Affirmative Action Employer.
UNIVERSITY OF LOUISVILLE
DEPARTMENT OF MATHEMATICS

CHAIRMAN. University of Louisville, Department of Mathematics seeks an established mathematician to be Department Chairman beginning Fall, 1989. Candidates should have active research program, substantial scholarly achievement, teaching and administrative experience, and interest in both undergraduate and graduate program development. Ph.D. in mathematics required. Research areas compatible with those already in Department are desirable, but not required. Experience directing Ph.D. theses desirable, but not essential. Appointment will be at Associate Professor or Professor level, depending upon qualifications, vitae, and at least three letters of recommendation to: Professor Richard Davitt, Department of Mathematics, University of Louisville, Louisville, KY 40292. Deadline for applications is January 3, 1989. AA/EOE

WEST VIRGINIA UNIVERSITY
DEPARTMENT OF MATHEMATICS

The Department of Mathematics seeks to make a faculty appointment in mathematics education at the Assistant/Associate Professor level. The position will commence August, 1989. Candidates are expected to have a doctorate with a strong background in mathematics, preferably geometry, and to have a strong record or potential in both research and teaching. Normal responsibilities of the position include research in mathematics or mathematics education and a two course teaching assignment per semester. The individual selected will be expected to participate in the department's current involvement with secondary mathematics teachers. The department offers a PhD in mathematics and a master's degree which includes a program for secondary mathematics educators.

Applications should submit a vita and have three letters of reference sent to James Lightbourne, Department of Mathematics, West Virginia University, Morgantown, WV 26506. To insure consideration, all application materials and letters of reference should be received by January 15, 1989. WVU is an Affirmative Action/Equal Opportunity Employer. Qualified women and minorities are encouraged to apply.

Classified Advertisements

UNIVERSITY OF SOUTHERN CALIFORNIA
DEPARTMENT OF MATHEMATICS
CENTER FOR APPLIED MATHEMATICS
LOS ANGELES, CALIFORNIA 90089-1113

The Department anticipates the establishment of a Center for Applied Mathematics, effective September, 1989, under the direction of H. T. Banks. In connection with this Center, and in addition to appointments listed elsewhere, the Department will hire one tenure-track Assistant Professor (or, at its option, a tenured Associate Professor or Professor). Applicants must show strong research promise in Applied Mathematics, and in the case of senior appointments, must have an outstanding record of research and scholastic achievement in Applied Mathematics.

Applications should be addressed to: Chairman, Search Committee, Department of Mathematics-ORB 306, University of Southern California, Los Angeles, CA 90089-1113, Attn: Center for Applied Mathematics. EOE/AA.
Classified Advertisements

MICHIGAN TECHNOLOGICAL UNIVERSITY
Department of Mathematical Sciences

Three tenure-track assistant professor positions are expected starting September, 1989. Applications in all areas of mathematics are invited. Candidates in computational mathematics or statistics are particularly encouraged to apply. A commitment to research and excellent teaching are required.

MTU is a state supported institution emphasizing science and engineering. The Department of Mathematical Sciences offers B.S. and M.S. degrees and is considering a Ph.D. program. There are 36 full time faculty with active programs in Mathematics, Applied Mathematics, Computational Mathematics, and Statistics.

To apply, send a curriculum vitae and arrange to have three letters of recommendation sent to Recruitment Committee, Department of Mathematical Sciences, Michigan Technological University, Houghton, MI 49931.

Michigan Technological University is an equal opportunity educational institution/equal opportunity employer.

UNIVERSITY OF HAWAII
DEPARTMENT OF MATHEMATICS

Applications are invited for two anticipated positions beginning Fall, 1989, one tenure-track and one temporary (one year). Rank open. Duties include mathematical research and teaching 6 credit hours per semester. Minimum qualifications include a Ph.D. commitment to research and teaching, and achievement appropriate to rank. Research interests complementing those of the Department are desirable. Normal salary range as of 10/88 is from $25,368 (minimum for assistant professor) to $57,804 (maximum for full professor). To apply, write to Professor Ronald Brown, Chairman, Department of Mathematics, 2565 The Mall, Keller 401A, Honolulu, HI 96822. Have 3 references send confidential letters directly to the chairman. DEADLINE FOR APPLICATION: 1/23/89. The University of Hawaii is an AA/EO employer.

WEST VIRGINIA UNIVERSITY
Department of Mathematics

The Department of Mathematics expects to make several Assistant/Associate level faculty appointments that will commence August, 1989. Candidates are expected to have a Ph.D. in mathematics or equivalent with a strong record or demonstrated potential in both research and teaching. Preference will be given to applicants whose research interests are in areas of algebra, analysis, combinatorics, applied mathematics, and numerical analysis. Normal responsibilities of the position include research and a two course teaching assignment per semester at the graduate or undergraduate level.

Applicants should submit a vita and have three letters of reference sent to James Lightbourne, Department of Mathematics, West Virginia University, Morgantown, WV 26506. To insure consideration all application materials and letters of reference should be received by January 15, 1989.

WVU is an affirmative action/equal opportunity employer. Qualified women and minorities are encouraged to apply.

UNIVERSITY OF WISCONSIN-MILWAUKEE
Department of Mathematical Sciences

The Department of Mathematical Sciences of the University of Wisconsin-Milwaukee anticipates a full or associate level professorship (with tenure) beginning in August, 1989. The appointment will be in applied analysis and/or dynamic systems. Duties for the position consist of research and teaching two courses per semester. Applicants must have a strong research and publication record. Salary is commensurate with experience and qualifications.

Applicants should submit a vita, a list of publications, and at least five letters of recommendation to Search Committee, Department of Mathematical Sciences, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, WI 53201 by January 27, 1989.

The University of Wisconsin-Milwaukee is an affirmative action/equal opportunity employer.

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
DEPARTMENT OF MATHEMATICS

The Department of Mathematics has faculty positions at all ranks. The department is especially interested in establishing a group in Numerical PDE/Scientific computation over the next five years. Access to the Alabama Super Computer (using a Sun Station and a T-1 line to a Cray X-MP/24) will be available in the near future. Other areas which will enhance our proposed Ph.D. in Applied Mathematics will be seriously considered. Applicants for senior positions must demonstrate excellence in research, while applicants for junior positions must exhibit the promise of excellence. Send as soon as possible a curriculum vitae, list of publications, a few selected reprints, and the names of three references to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/Equal Opportunity Employer.

BARD COLLEGE
TENURE TRACK POSITION
IN MATHEMATICS

Applications are invited for a tenure-track position in Mathematics at Bard College for the Fall of 1989. Bard is a Liberal Arts College with a young and expanding Mathematics Department. We are seeking someone with a strong interest in building an innovative mathematics program in a liberal arts context. Candidates must have a Ph.D. by the Fall of 1989, and a commitment to teaching and continued mathematical activity. Salary and rank depending on experience. To apply, submit a resume, a statement of teaching and research interests, and 3 letters of recommendation (at least one concerning teaching) to Prof. Ethan Bloch, c/o Dean's Office, Bard College, Annandale-on-Hudson, NY 12504. Deadline for applications is 1/1/89; late applications will be considered until the position is filled. For more information, call 914-758-6822 exts. 266, 265. Bard will have representatives at the AMS Employment Register at the Jan., 1989, meeting in Phoenix. Bard College is an AA/EOE.
POSITIONS AVAILABLE

UNIVERSITY OF ARIZONA
DEPARTMENT OF MATHEMATICS
TUCSON, ARIZONA 85721

Tenure track positions. Ph.D., excellent research record or potential, strong commitment to teaching required. Field is less important than ability but should complement existing strengths in algebra, computational science, differential equations, dynamical systems, geometry, mathematical physics, nonlinear analysis, number theory, probability and statistics. Applications received by February 1, 1989, will be considered first, if suitable candidates are not found then late applications will be reviewed. Send applications to Department Head, Department of Mathematics. The University of Arizona is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF SOUTH ALABAMA
DEPARTMENT OF MATHEMATICS AND STATISTICS

Two tenure-track positions at the Assistant Professor level starting September 1, 1989. Applicants must have a Ph.D. in Mathematics (earned or anticipated by appointment date). Strong research potential and a commitment to excellence in teaching are required. Preference given to fields complementing existing research specialties. Applications will be accepted until positions are filled, but should be completed by January 31, 1989, to ensure consideration. Please send detailed resume and three letters of recommendation to Dr. Suzanne McGill, Chair; Department of Mathematics and Statistics; University of South Alabama; Mobile, AL 36688. An Equal Opportunity/Affirmative Action Employer.

TRINITY UNIVERSITY
SAN ANTONIO, TEXAS
ASSISTANT/ASSOCIATE PROFESSOR OF MATHEMATICS

Trinity University invites applications and nominations for a tenure-track position in mathematics, appointment beginning August 1, 1989. The appointment will be made at the rank of Assistant Professor or Associate Professor, depending on qualifications. Responsibilities include teaching nine credit hours per semester, continuing scholarly activity, assisting in curriculum development as appropriate to the needs of the department and the university, advising and committee service.

Minimum qualifications are the Ph.D. in Mathematics or Applied Mathematics with excellence in and strong commitment to teaching. Preference given to candidates with teaching and research interests in one or more of the following areas: applied mathematics, numerical analysis, classical analysis, differential equations.

Founded in 1869, Trinity University occupies a modern campus overlooking the San Antonio skyline. Purposefully small and selective, with about 2700 students, Trinity stresses a high quality, undergraduate liberal arts and science program. San Antonio is a city of approximately 850,000 people situated in a metropolitan area of 1.2 million.

Closing date for applications is January 27, 1989. Send vita, transcripts and three letters of reference to:

Dr. Donald F. Bailey, Chairman
Department of Mathematics
Trinity University
715 Stadium Drive
San Antonio, Texas 78284

Trinity University is an equal opportunity affirmative action employer.

Radford University

The Department of Mathematics and Statistics is accepting applications for teaching positions to start in the fall of 1989. Ph.D in mathematics, statistics, or related areas required. Specialization and rank open. Submit letter of application, current vita, copies of undergraduate and graduate transcripts, and three recent confidential letters of reference to:

Dr. David L. Albig, Chairman
Department of Mathematics & Statistics
Radford University
Radford, VA 24142

Review of applications to begin on January 1; applications will be accepted until the position is filled. Minorities and women are encouraged to apply. EO/AA Employer.

Department of Mathematics
University of Toronto

Applications are invited from recent Ph.D.s for a tenure-stream position at Erindale Campus beginning July 1, 1989. This position which is subject to final budgetary approval is open to all branches of pure and applied mathematics.

Duties will consist of research and teaching and candidates must demonstrate clear strength in both.

Applicants should send their complete C.V. together with a list of publications and arrange to have at least three letters of reference sent directly to Professor D. Masson, Associate Chairman, Department of Mathematics, University of Toronto, Toronto, Canada, M5S 1A1.

To insure full consideration, this information should be received by January 31, 1989.

The University of Toronto encourages both men and women to apply.
Arizona Center for the Mathematical Sciences announces the
Third Annual Workshop for Advanced Undergraduates
CURRENT IDEAS IN NONLINEAR SCIENCE
March 4-7, 1989

The main goal of these workshops is to communicate to potential graduate students the level of excitement and activity in mathematical sciences today. The program will focus on topics in three areas:

(i) Geometry in Analysis and Number Theory (the geometry of bifurcations and catastrophes, arithmetic of algebraic curves)

(ii) Mathematical Physics (neural networks, spin glasses, cellular automata, random wave propagation, nonlinear optics, fluid turbulence)

(iii) Medical and Biophysics (inverse problems, excitable media, non-linear waves, reaction-diffusion, fibrillation cardiac arrhythmia)

Partial travel and subsistence support is available. The deadline for application material is February 3, 1989. Direct all correspondence to:

W. M. Greenlee or D. W. McLaughlin
Department of Mathematics, Program in Applied Mathematics
University of Arizona, Tucson, Arizona 85721
(602) 621-4664
**Classified Advertisements**

**UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN**
The Chancellor's Postdoctoral Fellowship Program

**PURPOSE:** To train more underrepresented minorities for research careers.

**AWARDS:** One year (possibly a second year) to promising applicants in all academic fields.

**STIPENDS:** $25,000-$30,000, some transportation costs, health coverage funds, and research-related expenses.

**ELIGIBILITY:** U.S. citizens or permanent residents; appropriate terminal degree in hand or before appointment begins; preference to high achievers in disciplines of limited postdoctoral opportunities.

**APPLICATION:** Curriculum vitae; statement of proposed research; sample publications/dissertation chapters; letters of reference from three evaluators.

**DEADLINE:** Application and letters by December 1, 1988; announcement of awards before March 25, 1989.

EOE/AA.

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**EMORY UNIVERSITY, ATLANTA, GA 30322**
DEPT. OF MATHEMATICS AND COMPUTER SCIENCE

The Department of Mathematics and Computer Science has two openings in mathematics to begin September 1, 1989. The positions are at the level of tenure-track assistant professor, or higher, in the case of exceptional candidates. Applicants must have a Ph.D. in mathematics and a strong record (or promise) of research.

The areas of functional analysis and numerical analysis are of particular interest to us, but applications will be considered from candidates with strong research credentials in any area of mathematics. Teaching load is 6 hrs/wk, including graduate and undergraduate courses.

Please send vita and names of three references to the above address, and have reference letters forwarded to us. Screening of applications will begin Feb. 1, 1989. Emory University is an equal opportunity/affirmative action employer.

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**OREGON STATE UNIVERSITY**

Assistant Professor position in Algebra, (Number Theory), Numerical Analysis, or Geometric-Topology will become available September, 1989. Salary depends on qualifications. Closing date January 20, 1989. Write to:

Professor Bent Petersen
Staff Selection Committee
Department of Mathematics
Oregon State University
Corvallis, Oregon 97331

Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973. OSU has a policy of being responsive to the needs of dual-career couples.

The Ohio State University
Department of Mathematics
Research Instructorships in Mathematics

Applications are invited for the position of research instructor in mathematics for the academic year 1989-90. Candidates should hold a Ph.D. (or equivalent) in mathematics and show strong research promise.

Please send credentials and have letters of recommendation sent to Professor Joseph Ferrar, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

The George Washington University
Tenure track position, Assistant Professor level, beginning September, 1989. Candidates must have a Ph.D. in Mathematics, commitment to excellence in teaching, and strong research potential in combinatorics. Send vita, statement of current research activities and three letters of recommendation to: Hugo D. Junghenn, Chair, Department of Mathematics, The George Washington University, Washington, D.C. 20052, by February 1, 1989. The George Washington University is an Equal Opportunity Educational Institution/Affirmative Action Employer.

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**THE UNIVERSITY OF MISSOURI-ST. LOUIS**

The Department of Mathematics and Computer Science seeks applicants for tenure-track positions in computer science or mathematics with an interest in computer science beginning in Fall, 1989.

Applicants who have an active interest in both teaching and research are encouraged to apply. Please send all applications, resumes and letters of reference to Jerrold Siegel, Chairman, Department of Mathematics and Computer Science, University of Missouri-St. Louis, 8001 Natural Bridge Road, St. Louis, Missouri 63121-4499. The University of Missouri-St. Louis is an Equal Opportunity/Affirmative Action Employer.

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**UNIVERSITY OF SOUTH FLORIDA**
Department of Mathematics

Tenure-track teaching and research positions are available beginning August, 1989. Applicants must possess a Ph.D. degree. Applicants specializing in Analysis and/or Computational Mathematics are preferred but other outstanding candidates will be considered. Rank and salary will depend on credentials. To apply send curriculum vitae and three letters of recommendation to Kenneth L. Pothoven, Chairman, University of South Florida, Department of Mathematics, Tampa, Florida 33620-5700. Application Deadline: February 10, 1989. The University of South Florida is an equal opportunity employer.

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**STATE UNIVERSITY OF NEW YORK AT BINGHAMTON**
Department of Mathematical Sciences

Invites applications at all levels for several openings. Senior applicants must have an outstanding research record. Junior applicants must show great promise. All areas, including mathematical computer science and statistics, will be considered. The department has a healthy doctoral program and an attractive future. Vita and letters of recommendation should be sent to: David L. Hanson, Chair, Dept. of Math. Sciences, SUNY-Binghamton, Binghamton, NY 13901. An AA/EOE.

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**THE UNIVERSITY OF MISSOURI-ST. LOUIS**

The Department of Mathematics and Computer Science seeks applicants for tenure-track positions in computer science or mathematics with an interest in computer science beginning in Fall, 1989.

Applicants who have an active interest in both teaching and research are encouraged to apply. Please send all applications, resumes and letters of reference to Jerrold Siegel, Chairman, Department of Mathematics and Computer Science, University of Missouri-St. Louis, 8001 Natural Bridge Road, St. Louis, Missouri 63121-4499. The University of Missouri-St. Louis is an Equal Opportunity/Affirmative Action Employer.

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**UNIVERSITY OF SOUTH FLORIDA**
Department of Mathematics

Tenure-track teaching and research positions are available beginning August, 1989. Applicants must possess a Ph.D. degree. Applicants specializing in Analysis and/or Computational Mathematics are preferred but other outstanding candidates will be considered. Rank and salary will depend on credentials. To apply send curriculum vitae and three letters of recommendation to Kenneth L. Pothoven, Chairman, University of South Florida, Department of Mathematics, Tampa, Florida 33620-5700. Application Deadline: February 10, 1989. The University of South Florida is an equal opportunity employer.

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**STATE UNIVERSITY OF NEW YORK AT BINGHAMTON**
Department of Mathematical Sciences

Invites applications at all levels for several openings. Senior applicants must have an outstanding research record. Junior applicants must show great promise. All areas, including mathematical computer science and statistics, will be considered. The department has a healthy doctoral program and an attractive future. Vita and letters of recommendation should be sent to: David L. Hanson, Chair, Dept. of Math. Sciences, SUNY-Binghamton, Binghamton, NY 13901. An AA/EOE.

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EMORY UNIVERSITY, ATLANTA, GA 30322
DEPT. OF MATHEMATICS AND COMPUTER SCIENCE

The Department of Mathematics and Computer Science has two openings in mathematics to begin September 1, 1989. The positions are at the level of tenure-track assistant professor, or higher, in the case of exceptional candidates. Applicants must have a Ph.D. in mathematics and a strong record (or promise) of research.

The areas of functional analysis and numerical analysis are of particular interest to us, but applications will be considered from candidates with strong research credentials in any area of mathematics. Teaching load is 6 hrs/wk, including graduate and undergraduate courses.

Please send vita and names of three references to the above address, and have reference letters forwarded to us. Screening of applications will begin Feb. 1, 1989. Emory University is an equal opportunity/affirmative action employer.
TEMPORARY POSITIONS

UNIVERSITY OF CALIFORNIA, LOS ANGELES
Department of Mathematics

(1) One or two E. R. Hedrick Assistant Professorships. Applicants must show very strong promise in research and teaching. Salary $36,000. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate's field. Preference will be given to applications completed by January 1, 1989.

(2) Two or three Research Assistant Professorships in Computational and Applied Mathematics. Applicants must show very strong promise in research and teaching. Salary $36,000. Three year appointment. Teaching load: four quarter courses per year, which may include one advanced course in the candidate's field. Preference will be given to applications completed by January 1, 1989.

(3) One or two Assistant Professorships in the Program in Computing (PIC). Applicants must show very strong promise in teaching and research, preferably in the general area of Logic, Language and Computation. Teaching load: four quarter programming courses and an advanced quarter course of the candidate's choice per year. Two year appointment, renewable once or twice. Salary range: $36,000-$42,000. Preference will be given to applications completed by January 1, 1989.

(4) One or two Lectureships in the Program in Computing (PIC). Applicants must show very strong promise in the teaching of programming. Teaching load: five quarter programming courses per year. One year appointment, renewable up to four times. Salary depends on experience, begins at $30,300.

(5) Subject to administrative approval, a few adjunct assistant professorships. Two year appointments. Strong research and teaching background required. Salary $31,500-$35,400 per year. Teaching load: five quarter courses per year.

Several positions for visitors and lecturers.

To apply, write to Alfred W. Hales, Chair, Department of Mathematics, University of California, Los Angeles, CA 90024-1555. Attn: Staff Search. UCLA is an Equal Opportunity, Affirmative Action Employer.

UNIVERSITY OF WYOMING
Department of Mathematics

Invites applications for the following positions:

One or more tenure-track positions at the assistant/associate professor level in the areas of applied mathematics, algebraic/computational combinatorics, functional analysis, numerical linear algebra.

One or more visiting positions at levels appropriate for the applicant.

Send resume and three letters of recommendation to:

Professor W. Bridges, Chairman
Mathematics Department
P.O. Box 3036 University Station
University of Wyoming
Laramie, WY 82071-3036
(307) 766-4222

Applications completed by January 31, 1989, will be given first consideration. The University of Wyoming is an Equal Opportunity/Affirmative Action Employer.

MURRAY STATE UNIVERSITY, Department of Mathematics & Statistics. Applications are invited for a tenure-track position at the Assistant or Associate Professor level beginning August, 1989. Preferences will be given to applicants in statistics or numerical analysis. Responsibilities will include a maximum three course, 12-hour teaching load and continuing research activity. Internal grants for support of research and other scholarly activities are available. Selection will be based on evidence of teaching effectiveness and research potential. A Ph.D. in statistics or mathematics is required. Salary will be competitive, screening will begin Dec. 1, 1988, and continue until the position is filled. Send resume and request three letters of recommendation to:

Dr. Kenneth Fairbanks
Search Committee
Department of Mathematics
Murray State University
Murray, Ky. 42071

Murray State University is an EO/AA employer.

UNIVERSITY OF VICTORIA
DEPARTMENT OF MATHEMATICS

The Department of Mathematics invites applications for a tenure-track faculty appointment at the Assistant Professor level to commence on July 1, 1989. Applicants should have a Ph.D. in Mathematics and a strong commitment both to research and undergraduate teaching. Preference will be given to individuals who can interact with Department members in one or more of the areas of analysis, applied mathematics, discrete mathematics, mathematical physics, statistics, and stochastic modelling. The University of Victoria offers equal employment opportunities to qualified male and female applicants. Women are particularly encouraged to apply. Canadian immigration regulations require the University to assess applications from Canadian Citizens and permanent residents of Canada before assessing applications from other persons.

Applicants should send a curriculum vitae and three letters of reference to Dr. C. R. Miers, Chairman, Department of Mathematics, University of Victoria, P.O. Box 1700, Victoria, B.C., V8W 2Y2. The closing date for applications is February 15, 1989.

ASSISTANT PROFESSORSHIPS
Department of Mathematics
University of California at Berkeley
Berkeley, CA 94720

We invite applications for one or more positions effective July 1, 1989, at the tenure-track Assistant Professor level, subject to budgetary approval, in the areas of algebra, analysis, applied mathematics, foundations, or geometry and topology. Applicants are expected to have demonstrated outstanding research potential, normally including major contributions beyond the doctoral dissertation. Send by January 15, 1989, a curriculum vitae, list of publications, and a few selected reprints or preprints. Ask three people to send letters of recommendation to Marc A. Rieffel, Vice Chair for Faculty Affairs, at the above address. The University of California is an Equal Opportunity, Affirmative Action Employer.
THE UNIVERSITY OF FLORIDA  
Department of Mathematics

The Department of Mathematics is in the third year of a five-year program to fill over 20 new tenure-track faculty positions with mathematicians of exceptional caliber. The Department invites applications for six tenure-track positions for the fall semester, 1989. Applications from junior candidates are especially welcome.

Outstanding candidates in all areas of applied and pure mathematics are invited to apply for these positions. Senior candidates should have distinguished research records, and junior candidates are expected to have made significant research contributions. Every candidate is expected to possess a strong commitment to teaching.

One position will be reserved for a senior candidate in Partial Differential Equations. Strong preference will be given to Arithmetic Geometers and Number Theorists in Analysis.

Candidates should forward a resume (including a list of publications) and should arrange for at least three letters of recommendation to be sent to:

David A. Drake, Chair  
Department of Mathematics  
University of Florida  
201 Walker Hall  
Gainesville, Florida 32611

All applications for the academic year 1989-1990 should be complete by December 31, 1988. The University of Florida is an equal opportunity employer.

OREGON STATE UNIVERSITY  
Andreotti Assistant Professor of Mathematics

The Andreotti Assistant Professor position in mathematics will become available September, 1989. Salary depends on qualifications. Closing date January 20, 1989. Write to:

Professor Bent Petersen, Chair  
Andreotti Professorship  
Selection Committee  
Department of Mathematics  
Oregon State University  
Corvallis, OR 97331

Oregon State University is an Affirmative Action/Equal Opportunity Employer and complies with Section 504 of the Rehabilitation Act of 1973. OSU has a policy of being responsive to the needs of dual-career couples.

LOYOLA UNIVERSITY  
DEPARTMENT OF MATHEMATICAL SCIENCES

The Department of Mathematical Sciences anticipates at least one tenure track position and several one year positions beginning in August, 1989. Requirements are the Ph.D., an active research program in any area, and a commitment to quality teaching. The department offers courses in mathematics, computer science, and statistics at the undergraduate and masters level. Interviews will begin in January and continue until all positions are filled. Send detailed C.V. and three letters of recommendation to:

Professor R. J. Lucas  
Department of Mathematical Sciences  
Loyola University of Chicago  
Chicago, IL 60626

Loyola University of Chicago is an Equal Opportunity/Affirmative Action Employer.

HARVEY MUDD COLLEGE  
MATHEMATICS DEPARTMENT

Harvey Mudd College has one entry level position in mathematics. Strong preference will be given to applicants who have received a Ph.D. degree no earlier than 1985. We are an affirmative action employer.

Excellence in teaching is essential. Any applicant should have a strong background including evidence of ongoing research, in one of the following: statistics, operations research, theoretical computer science, or some area of discrete mathematics. In addition, applicants must show a breadth of mathematical interests and the ability to work well with others in developing our departmental program. Applicants must be comfortable with the use of computers.

Harvey Mudd College is a small private undergraduate college (approx. enrollment 550). Our students major in chemistry, engineering, mathematics or physics. A year course in calculus at the high school level is a prerequisite for admission. Ph.D. degrees have been earned by 40.7% of the college's pre-1980 graduates—the highest percentage in the nation. The College is affiliated with four other undergraduate colleges and a graduate school in Claremont, an academic community with about 5,000 students.

Applications received by February 3, 1989, will be considered first. Applicants should send a curriculum vitae, a short description of their research, and arrange to have 3 letters of reference sent directly to:

Selection Committee  
Department of Mathematics  
Harvey Mudd College  
Claremont, CA 91711-5990
Classified Advertisements

POSITIONS AVAILABLE

MARY WASHINGTON COLLEGE
Department of Mathematics

A tenure-track assistant professor in mathematics position is anticipated starting Fall '89. Candidates should have (by Aug. '89) a Ph.D. in pure or applied mathematics, and must possess both a strong commitment to teaching and to continuing scholarly development. MWC is a small (3200), state-supported, co-educational, selective, under-graduate, liberal arts college located 50 miles from Richmond and Washington, D.C. Teaching load is approx. 110 students each semester in 9 or 12 contact hrs/wk. Send resume, graduate transcript, and 3 letters of reference—all to arrive by January 23, 1989—to: J. Larry Lehman, Search Committee Chairman, Department of Mathematics, Mary Washington College, Fredericksburg, VA 22401-5358. EOE/AA.

OHIO UNIVERSITY
Department of Mathematics

The Department of Mathematics anticipates the appointment of two to four tenure-track assistant/associate professors beginning September 1, 1989. Salary will be competitive. Duties include research and teaching at the under-graduate and graduate level. Applicants must have a Ph.D. in Mathematics and have research interests compatible with the current faculty in algebra, analysis, differential equations, or topology. For the associate professor position only exceptionally well-qualified individuals will be considered. Send resume and have three letters of recommendation sent to Shih-liang Wen, Chairman, Dept of Math, Ohio University, Athens, Ohio 45701. The deadline for applications is January 1, 1989.

Ohio University is an Equal Opportunity and Affirmative Action Employer.

UNIVERSITY OF PITTSBURGH
DEPARTMENT OF MATHEMATICS AND STATISTICS

invites applications for the following positions:
1) Specialist in partial differential equations or applied mathematics, including scientific computation. Rank open.
2) Two positions, one at a senior level, in pure mathematics other than differential equations.

Applicants should have outstanding research accomplishment or potential. Excellence in teaching is also required. Positions are contingent upon available funding. Applicants for a junior position should have resume and at least 3 letters of recommendation sent to Stuart Hastings, Chairman. More senior applicants can write to the same address. The University of Pittsburgh is an Equal Opportunity/Affirmative Action Employer. Women and minorities are especially encouraged to apply.

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
Dhahran – Saudi Arabia

DEPARTMENT OF MATHEMATICAL SCIENCES

Needs

Faculty members for teaching graduate and undergraduate courses in all areas of Mathematical Sciences. Ph.D. in Mathematics is required. Candidates must have strong research potential or accomplishments and demonstrated excellence in teaching. Preferred areas of research are Applied Mathematics and Numerical Analysis.

The University offers attractive salary and benefits plus air conditioned furnished housing and air transportation to and from Dhahran each year. Ten months duty each year with two months vacation salary. Minimum regular contract for two years, renewable.

Apply before December 31, 1988, with complete resume and supporting documents to:

Dean of Faculty & Personnel Affairs
KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPT. NO. MATH/540-A
DHAHRAN — 31261, SAUDI ARABIA

1416
NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY
One tenure-track assistant professorship, beginning fall, 1989. A Ph.D. and a commitment to both liberal arts education and continued research are expected of candidates to join a young, growing department. Computer science expertise is desirable. St. Mary's is a coeducational college of over 3400 students, located 10 miles east of Berkeley. Current salary range is $27,415-$32,628.

Send resume and 3 letters of recommendation, at least 1 of which discusses teaching ability, to J. R. Sangwine-Yager, Chair, Dept. of Mathematical Sciences, P.O. Box 3517, St. Mary's College, Moraga, CA 94575. Evaluation of candidates will begin January 30, 1989, and continue until the position is filled. Interviews will be held at the AMS meeting in Phoenix, AZ January, 1989. An EOE/AA employer.

Department of Mathematics
University of Toronto

Applications are invited from recent Ph.D.s for several three year limited term positions at the Main Campus and Erindale Campus beginning July 1, 1989.

These positions, which are subject to final budgetary approval, are open to all branches of pure and applied mathematics. Duties will consist of research and teaching and candidates must demonstrate clear strength in both.

Applicants should send their complete C.V. together with a list of publications and arrange to have at least three letters of reference sent directly to Professor D. Masson, Associate Chairman, Department of Mathematics, University of Toronto, Toronto, Canada, M5S 1A1. To insure full consideration, this information should be received by January 31, 1989.

The University of Toronto encourages both men and women to apply. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents.

ENDOWED POSITION IN APPLIED MATHEMATICS

Nominations and applications are sought for an endowed position in applied mathematics. The position (yet unnamed) is permanently funded by an endowment and is expected to lead to tenure. Other attractive features of the position include a reduced course load and the possibility of budget supplements for travel and secretarial support. A specific responsibility of the holder of this position will be the establishment and supervision of a Center for Applied Mathematics within the Department of Mathematics, focused on the preparation of undergraduates for work in applied mathematics, including opportunities for undergraduate research and for collaboration with the region's profit and non-profit institutions on specific problems.

The successful applicant for this position will hold a Ph.D. in mathematics or applied mathematics, have a recognized program of research in one or more areas of applied mathematics, demonstrate good organizational and interpersonal skills, and share a commitment to quality teaching in a liberal arts environment. The salary and rank of appointment will be appropriate for the candidate selected.

The College of St. Thomas, the largest private college in Minnesota, is located one block from the Mississippi River in the heart of the attractive and dynamic Twin Cities metropolitan area. For over a century the college has provided a strong program of liberal arts education in the Catholic tradition of service to the greater community. The Department of Mathematics has a current faculty of 12, representing a variety of mathematical interests.

Application materials, including a letter of interest, curriculum vita, and three letters of recommendation (including comments on the applicant’s experience and promise in the areas of teaching, research, and leadership) will be accepted until December 31, 1988, and, thereafter, until the position is filled. Applications, nominations, and inquiries should be sent to John T. Kemper, Chair, Department of Mathematics, College of St. Thomas, St. Paul, MN 55105. Individuals from both academic and industrial backgrounds whose interests and credentials are compatible with the requirements of the position are encouraged to apply. The College of St. Thomas is an equal opportunity/affirmative action employer.

WILLIAM PATERSON COLLEGE
Mathematics Department

Three tenure track positions in Mathematics are available beginning September 1, 1989, at least one of which will be filled by a statistician. Applicants must possess the Ph.D. A strong commitment to undergraduate teaching and establishment of an active research program are expected. Current research interests in the Department include discrete mathematics, statistics, differential geometry, and topology. Computer facilities are available for teaching and research purposes. Salary and rank are based on background and experience. Submit a letter of application, current vitae, and three letters of reference concerning teaching and research abilities by January 15, 1989, to E. Phadia, Chairperson, Department of Mathematics, William Paterson College, Wayne, New Jersey 07470. W.P.C. is an Equal Opportunity/Affirmative Action Employer.

CASE WESTERN RESERVE UNIVERSITY
DEPARTMENT OF MATHEMATICS AND STATISTICS

Tenure-track, possibly senior, positions anticipated to begin August 15, 1989. Outstanding research record and/or proven research potential and teaching excellence required. Preferred areas: statistics and probability (including applications in physics, chemistry and computer science) but candidates in areas of global analysis, dynamical systems, functional analysis, partial differential equations, and numerical analysis will also be considered. Women and minority groups candidates are especially encouraged to apply. Visiting positions in the above areas also possible. Send vita plus three letters of recommendation to Professor W. A. Woyczynski, Chairman, Department of Mathematics and Statistics, Case Western Reserve University, Cleveland, OH 44106. An affirmative action equal opportunity employer.
**Classified Advertisements**

**POSITIONS AVAILABLE**

**OKLAHOMA STATE UNIVERSITY**
**DEPARTMENT OF MATHEMATICS**

Several tenured, tenure-track and visiting positions at all professorial ranks are anticipated for Fall, 1989. All areas are under consideration, but we especially encourage applications in algebraic geometry, differential geometry, topology, several complex variables, harmonic analysis, probability, applied math, and PDEs. Normal duties include research and at most six hours teaching per semester. Minimum qualifications are a Ph.D. in mathematics or a related field, evidence of research achievement or potential, and a commitment to teaching. Post-doctoral experience is desirable, but not essential. For full consideration, send a resume and arrange to have three confidential letters of reference sent by January 15, 1989, to B. Conrey, Appointments Committee Chairman, Department of Mathematics, Oklahoma State University, Stillwater, OK 74078-0613. O.S.U. is an equal opportunity/affirmative action employer. Women and minorities are especially encouraged to apply.

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**TEMPORARY POSTDOCTORAL POSITIONS**

**Department of Mathematics**

University of California at Berkeley

Berkeley, CA 94720

Several temporary positions beginning in Fall, 1989, are anticipated for new and recent Ph.D.s in any area, in the areas of algebra, analysis, applied mathematics, foundations, or geometry and topology. The terms of these appointments may range from one to three years. Applicants for NSF or other postdoctoral fellowships are encouraged to apply for these positions; combined teaching/research appointments may be made for up to three years. Mathematicians whose research interests are close to those of regular department members will be given some preference. Send by January 15, 1989, a resume and reprints, preprints, and/or a dissertation abstract. Ask three people to send letters of recommendation to Marc A. Rieffel, Vice Chair for Faculty Affairs, at the above address. The University of California is an Equal Opportunity, Affirmative Action Employer.

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**THE CLAREMONT GRADUATE SCHOOL**
**DEPARTMENT OF MATHEMATICS**

The department has a regular position at the assistant/associate professor level beginning September, 1989. CGS is the graduate component of the six independent Claremont Colleges and offers Master’s and Ph.D. degrees in pure and applied mathematics. Activities would include research and teaching, directing Mathematics Clinic projects solving industrial problems, and involvement in a joint program in engineering mathematics. Experience with the application of mathematics or statistics to engineering problems such as pattern recognition or image processing would be valuable.

Send curriculum vitae and three letters of recommendation to Professor William Lucas, Department of Mathematics, The Claremont Graduate School, Claremont, CA 91711.

CGS is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and minority candidates.

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**MATHEMATICS DEPARTMENT, UNIVERSITY OF CALIFORNIA, SANTA CRUZ, CA 95064**

The Mathematics Department at the University of California, Santa Cruz is recruiting for one position in either linear analysis, geometry, topology, or algebra. The teaching load is 4 courses. Rank: Assistant Professor (possibly Associate I). Minimum Qualifications: Ph.D. in Mathematics with strong research and teaching credentials. Salary: $31,500–37,200. Effective: July 1, 1989. Applicants should send vitae, four letters of recommendation and information about their research and teaching experience to Recruitment Committee, Mathematics Department, University of California, Santa Cruz, CA 95064. Closing Date: December 31, 1988. Please refer to #129-889 in your reply.

UCSC IS AN EEO/AA/IRCA EMPLOYER

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**INDIANA UNIVERSITY-PURDUE UNIVERSITY AT INDIANAPOLIS**
**DEPARTMENT OF MATHEMATICAL SCIENCES**

The Department of Mathematical Sciences at IUPUI is seeking applicants for several tenure-track positions beginning in August, 1989. An earned doctorate and an excellent research record or potential are required. Strong applicants in all areas of pure and applied mathematics will be considered.

IUPUI is a comprehensive urban university with over 24,000 students. The department offers B.S., M.S., and Ph.D. degrees from Purdue University. The university offers excellent fringe benefits and competitive salaries. Send resume and three letters of recommendation to Professor C. D. Aliprantis, Acting Chairman, Department of Mathematical Sciences, IUPUI, 1125 East 38th Street, P.O. Box 847, Indianapolis, IN 46223. Closing date: January 15, 1989. Late applications will be considered until positions are filled. IUPUI is an Affirmative Action/Equal Opportunity Employer.

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1418 NOTICES OF THE AMERICAN MATHEMATICAL SOCIETY
UNIVERSITY OF WISCONSIN-MADISON
Department of Mathematics
Employment Opportunities

The Department of Mathematics at the University of Wisconsin-Madison solicits applications for the following positions, to begin fall, 1989.

Tenure and Tenure Track Positions. Appointments will be made at the Assistant Professor level unless qualifications and experience require appointment at higher rank.

Van Vleck Assistant Professorships. Applications are invited from mathematicians (of any age) who are recent recipients of a doctorate. Ordinarily only those applicants who have received their degree since 1986 and prior to September, 1989, will be considered. Preference will be given to candidates whose research interests are compatible with the research goals of the department. Candidates should have a strong commitment to good teaching and exhibit outstanding potential for mathematical research. The salary will be dependent on experience and will be at least $30,500 per academic year. Appointments are for a specified term of three years. The usual teaching load is two courses per semester, with at least one in the applicant's specialty every other year. There is a high probability of additional income through research or teaching during summers between consecutive years of appointment.

Application forms are available from the Hiring Committee, Department of Mathematics, 480 Lincoln Drive, Madison, WI, 53706. Supporting materials should include a vita, a one to three page abstract of the candidate's dissertation, and three or four letters of recommendation, at least one of which discusses the candidate's experience and capabilities as a teacher in detail.

Applications will be accepted until all positions are filled; however, in order to ensure full consideration, the application and all supporting materials should be received by December 31, 1988.

The University of Wisconsin is an AA/EOE employer.

The Immigration Reform and Control Act of 1986 requires the University to verify the identity and work authorization of the successful applicant. Offer of employment is contingent upon verification.

WORCESTER POLYTECHNIC INSTITUTE

The Department of Mathematical Sciences will have several tenure track positions at all levels for fall of 1989. These positions require a strong research record or potential and evidence of quality teaching. Fields of interest are numerical analysis, computational fluid mechanics, nonlinear PDE, optimization, control theory, dynamical systems, applied discrete mathematics, statistics/applied probability.

WPI, the nation's third oldest college of science and engineering, offers degrees through the Ph.D. The Mathematical Sciences Department currently offers an undergraduate and master's degree in applied mathematics. Worcester, Massachusetts is the second largest city in New England, approximately 40 miles west of Boston.

Interested applicants should send a curriculum vitae to: Samuel M. Rankin, III, Head, Department of Mathematical Sciences, 100 Institute Rd., Worcester, MA 01609. Applications will be accepted until the positions are filled. EOE/AA.

AUBURN UNIVERSITY, DIVISION OF MATHEMATICS
DEPARTMENT OF FOUNDATIONS, ANALYSIS, AND TOPOLOGY

We have one tenure-track Assistant Professor position for Fall, '89. We hope to hire someone in numerical analysis, but will also consider applicants in other areas of applied mathematics and analysis, and in logic and set theory. We also have one at least Visiting Assistant Professor position; applicant's area of research should be compatible with the interests of present faculty.

Send vita and three letters of recommendation to George Kozlowski, Head, Department of Foundations, Analysis and Topology, Auburn University, AL 36849. Minorities and women are encouraged to apply.

AUBURN UNIVERSITY IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.
**POSITIONS AVAILABLE**

**HOBART AND WILLIAM SMITH COLLEGES**  
Department of Mathematics and Computer Science

Assistant Professor, tenure track position beginning in September, 1989. Salary based on qualifications and experience. Applicants should have a Ph.D. in computer science or a Ph.D. in mathematics and a strong background (preferably a master's degree) in computer science. Duties include teaching all levels of undergraduate computer science and some mathematics, and participating in the Colleges’ Interdisciplinary General Curriculum. A strong commitment to teaching and promise of continued scholarly activity required. Teaching load: two courses per trimester. Hobart and William Smith are coordinate, four year, liberal arts colleges, committed to teaching and interdisciplinary study with a combined enrollment of 1900 students. Within an hour’s drive are three major universities: Cornell, Rochester, and Syracuse.

Send detailed resume, three letters of recommendation (at least one including comments on teaching), and undergraduate and graduate transcripts (photocopies acceptable) to: Prof. David Belding, Department of Mathematics and Computer Science, Hobart and William Smith Colleges, Geneva, NY 14456. Evaluation of applications will begin January 15, 1989, and will continue until the position is filled. Women and minorities are encouraged to apply. An Equal Opportunity/Affirmative Action Employer.

Baruch College/The City University of New York  
Department of Mathematics

The department seeks candidates for several tenure-track positions beginning September 1, 1989. PhD and evidence of strong research and success in undergraduate teaching required; record of funded research desirable. Applicants from all fields and levels invited. Send resume and names only of three references to: Chair, Department of Mathematics, Baruch College/CUNY, 17 Lexington Avenue, Box 509, New York, NY 10010. AA/EEO.

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**Miami University, Oxford, Ohio**  
Department of Mathematics and Statistics

Anticipates a tenure track assistant professorship beginning August, 1989. Duties include teaching 8-9 hours per semester, continuing scholarship, and service. Applicants should have a Ph.D. in pure or applied mathematics by 8/89. Please send vita, graduate transcript and three reference letters to John Skillings, Department of Mathematics and Statistics, Miami University, Oxford, Ohio 45056 by February 1, 1989. Women and minorities are encouraged to apply. Miami provides equal opportunity in employment and education.

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**THE PENNSYLVANIA STATE UNIVERSITY**  
DEPARTMENT OF MATHEMATICS  
226 MC ALLISTER BUILDING (N)  
UNIVERSITY PARK, PA. 16802

Applications are invited for tenure track faculty positions at all levels. Candidates from all areas of mathematics are welcome to apply (Ph.D. required). Inquiries should be accompanied by a vitae, publications record and a list of references to Professor Richard Herman, Chairman at the above address. Applications will be accepted until December 15, 1988, or until positions are filled.

**AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER.** Women and minorities are encouraged to apply.

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**DEPARTMENT OF MATHEMATICS AND STATISTICS**  
UNIVERSITY OF NEBRASKA-LINCOLN  
LINCOLN, NE 68588-0323

Tenure-track position at the Assistant Professor level in either Combinatorics or Global analysis available Fall, 1989. Ph.D. required with strong potential for research and quality teaching. Send vita and three letters of recommendation to Prof. Earl Kramer, Search Committee Chair, Department of Mathematics and Statistics, University of Nebraska-Lincoln, Lincoln, NE 68588-0323. AA/EEO. Application deadline February 1, 1989, or until position is filled. Women and minorities are especially encouraged to apply. 402-472-7246.

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**EMPORIA STATE UNIVERSITY**  
Division of Mathematics

Applications are invited for two or more tenure track positions starting Fall, 1989 at the rank of Assistant Professor. PhD in mathematics is required. Excellence in teaching and commitment to scholarly and creative activities is expected. Screening will begin March 1, 1989, and continue until positions are filled. Send resume and three letters of reference to: Jim Calvert, Interim Chair, Division of Mathematical and Physical Sciences, Emporia State University, Emporia, KS 66801. AA/EEO.

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**CANISIUS COLLEGE**  
DEPARTMENT OF MATHEMATICS

A second tenure track position (Assistant Professor) in mathematics is available in late August, 1989. Applicants must have a Ph.D. in mathematics and a strong commitment to quality teaching. Salary and fringe benefits are competitive commensurate with credentials and experiences.

Applicants should send resume, transcripts and three letters of recommendation to Dr. Richard Escobales, Chairman, Dept. of Mathematics, Canisius College, Buffalo NY 14208.

The Department is looking to expand its offerings and options while at the same time maintaining its sound preparation for students with mathematical potential. EOE/AA.
POSITIONS AVAILABLE
THE OHIO STATE UNIVERSITY
DEPARTMENT OF MATHEMATICS

The Department of Mathematics of The Ohio State University hopes to fill several positions, both visiting and permanent, effective Autumn Quarter, 1988. Candidates in all areas of applied and pure mathematics are invited to apply. Significant research accomplishments or exceptional research promise, and evidence of good teaching ability, will be expected of successful applicants.

Please send credentials and have letters of recommendation sent to Professor Joseph Farrar, Department of Mathematics, The Ohio State University, 231 W. 18th Avenue, Columbus, Ohio 43210. Review of resumes will begin immediately.

The Ohio State University is an Equal Opportunity/Affirmative Action Employer.

THE UNIVERSITY OF ALABAMA
MATH FACULTY POSITIONS

The department expects to fill from two to five tenure track positions at the rank of Assistant Professor, to begin August 16, 1989. Areas of special interest are: algebra, analysis, continuum mechanics, computational mathematics, differential equations, differential geometry, optimization, stochastic modeling, and topology. Applicants should have or reasonably expect to have by August 16, 1989, a Ph.D. or the equivalent. Excellence in both teaching and research is required. We also invite applications for visiting positions. Women and minorities are particularly encouraged to apply. Send a curriculum vitae, reprints and/or preprints, and at least three letters of recommendation to: Search Committee, Dept. of Mathematics, The University of Alabama, Box 870350, Tuscaloosa, AL 35487-0350. EOE/AA.

Deputy Director

MATHEMATICAL SCIENCES RESEARCH INSTITUTE

The Mathematical Sciences Research Institute at Berkeley is seeking a Deputy Director effective in the fall of 1990; the exact starting date is flexible. The position will be at least half time, and the salary will be determined accordingly. Fringe benefits are negotiable. The position is regarded as a rotating one with the term of service normally between three and five years.

The Deputy Director will assist the Director of the Institute in providing scientific and administrative leadership for the Institute. The candidate should have an established record of research in some area of the mathematical sciences and the inclination and ability to assume administrative duties. Duties will include roles in selection and planning of future programs, in selection of participants, in development of budgets, in formulation of scientific and administrative policies, and in supervision of the Institute library.

While a mathematician in the immediate vicinity of Berkeley might find it easier to make arrangements with his or her home institution for an extended leave of absence with partial salary, the search will not be limited to such candidates. We urge anyone whose financial needs and career goals are compatible with the terms of the position to apply. Candidates should send a resume to Irving Kaplansky, Director, Mathematical Sciences Research Institute, 1000 Centennial Drive, Berkeley, CA 94720 by May 1, 1989 at the latest.

An Equal Opportunity/Affirmative Action Employer

AUBURN UNIVERSITY
Department of Algebra, Combinatorics and Analysis

The department expects to make some visiting or temporary appointments and some tenure track appointments beginning September, 1989. Research compatible with department interests in algebra, analysis, combinatorics (particularly coding theory or cryptography), differential equations, linear algebra or probability desired. Evidence of good teaching required. Rank and salary commensurate with qualifications.

Send resume and arrange for three letters of reference to be sent to James Wail, 120 Math Annex, Auburn University, AL 36849-5307.

Minorities and women are encouraged to apply.

AUBURN UNIVERSITY IS AN EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER.
POSSITIONS AVAILABLE

TENURED POSITION
Department of Mathematics
University of California at Berkeley
Berkeley, CA 94720

We invite applications for one or more positions effective July 1, 1989, at tenure level (Associate or full Professor), subject to budgetary approval, in the areas of algebra, analysis, applied mathematics, foundations, or geometry and topology. Demonstrated leadership in research is expected of applicants. Send by January 15, 1989, a curriculum vitae, list of publications, a few selected reprints or preprints, and the names of three references, to Marc A. Rieffel, Vice Chair for Faculty Affairs, at the above address. The University of California is an Equal Opportunity, Affirmative Action Employer.

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
DEPARTMENT OF MATHEMATICS
The Department of Mathematics has faculty positions at all ranks. The department is especially interested in Numerical PDE/Scientific computation, mathematical physics, dynamical systems and nonlinear analysis. Faculty members have access to the Alabama Super Computer (using a Sun Station and a T-1 line to a Cray X-MP/24). Other areas which will enhance our new Ph.D. in Applied Mathematics will be seriously considered. Applicants for senior positions must have demonstrated excellence in research, while applicants for junior positions must exhibit the promise of excellence. Send as soon as possible a curriculum vita, selected reprints, and three letters of reference (candidates for senior positions may choose to submit a list of references instead) to Search Committee, Department of Mathematics, University of Alabama at Birmingham, Birmingham, AL 35294. UAB is an Affirmative Action/Equal Opportunity Employer.

DEPARTMENT OF MATHEMATICS AND STATISTICS
UNIVERSITY OF NEBRASKA-LINCOLN
LINCOLN, NE 68588-0323
Tenure-track position at the Associate (or Assistant) Professor level in partial differential equations available Fall, 1989. Ph.D. required with proven excellence in teaching, a strong research record, and the ability to direct doctoral dissertations. Preference to candidates with expertise in numerical methods or modeling. Send vita and three letters of recommendation to Prof. Tom Shores, PDE Search Committee Chair, Department of Mathematics and Statistics, University of Nebraska-Lincoln, Lincoln, NE 68588-0323. AA/EEO. Application deadline February 1, 1989, or until position is filled. Women and minorities are especially encouraged to apply. 402-472-7233

CALIFORNIA STATE UNIVERSITY, LONG BEACH
Department of Mathematics
Seven tenure-track positions beginning Fall, 1989: Algebra or Analysis (3 positions); Applied Math, with Numerical Analysis, applied PDE or applied Probability preferred (2 positions); Statistics with Actuarial Math (1 position); Math Education (1 position). All positions require completed PhD, evidence of excellent teaching, strong research record or potential. Asst. or Assoc. Prof. preferred; applicants with distinguished records in teaching and research may be considered for Professor. Must be US citizen or permanent resident prior to offer of appointment. Further details of duties, salary range, specialty and degree requirements provided on request. Positions open until filled, but selection begins from applicants with complete files (resume, transcript, 3 reference letters) 12-01-88. Apply to C. W. Austin, Chair, Mathematics Department, CSU, Long Beach, CA 90840. CSULB is an Affirmative Action Equal Opportunity Employer.

ILLINOIS WESLEYAN UNIVERSITY,
DEPARTMENT OF MATHEMATICS,
BLOOMINGTON, IL 61702
Applications are invited for a tenure track position at the rank of Assistant Professor starting the fall semester 1989. Candidates must possess a Ph.D. in mathematics, a dedication to quality teaching in an independent, liberal arts university, and active research interests. Preference may be given to individuals who have active professional interests in applied mathematics and either engineering or computer science. Women and minorities are encouraged to apply. Candidates should submit a vita and three letters of recommendation to Melvyn W. Jeter, Head, Department of Mathematics, Illinois Wesleyan University, Bloomington, IL 61702. Equal Opportunity Employer.

HEAD, DEPARTMENT
OF MATHEMATICS
NORTH CAROLINA STATE UNIVERSITY
Applications are invited for the position of Head, Department of Mathematics starting Fall, 1989. The department, part of the College of Physical and Mathematical Sciences, has a faculty of 90 and offers programs leading to B.S., M.S. and Ph.D. degrees with majors in either mathematics or applied mathematics. NCSU has an enrollment of 24,000, is one of the three research universities adjacent to the Research Triangle Park and is a major research institution within the University of North Carolina System. The successful candidate should have proven research ability, commitment to quality teaching and administrative ability. Applicants should send a resume with names of four references prior to January 1, 1989, to: Richard R. Patty, Search Committee Chairman, Box 8202, North Carolina State University, Raleigh, NC 27695-8202. NCSU is an Equal Opportunity/Affirmative Action Employer.
The Mathematical Sciences Institute of Cornell University is beginning its search for postdoctoral visitors for the academic year beginning August, 1989. This is the fourth year of operation of the Institute, which supports research in the following areas:

- Applied Analysis, T. J. Healey, 607-255-3738
- Physical Mathematics, J. T. Jenkins, 607-255-7185

Details about each program can be obtained from the corresponding coordinator, whose name and telephone number are shown above. Inquiries addressed to the appropriate program coordinator also may be sent to:

Mathematical Sciences Institute
Cornell University
Ithaca, NY 14853-2602

Application Procedure for Postdoctoral Visitors

The Institute prefers scientists who are not more than five years beyond the doctoral degree. Candidates are eligible for academic year appointments with possible extension to a second academic year. The salary is $27,300.00 for nine months, plus benefits. The deadline for '89-'90 applications is January 31, 1989, and awards will be made by March 15, 1989. In addition to a curriculum vitae, three (3) letters of recommendation are required, one of which should come from the thesis advisor. The candidate should specify a mathematical scientist at Cornell with whom (s)he expects to be associated. Applications for research in the following fields are particularly sought:

- Microstructural Continuum Mechanics
- Probability Theory and Statistics
- Symbolic Computation
- Parallel Computation

A list of mathematical scientists is available from the Institute office. Call 607-255-8005.

Millersville University enrolls more than 7,000 students; it is the oldest of the 14 universities in the Pennsylvania State System of Higher Education. The campus is located in a suburb of Lancaster, a county which offers a safe, pleasant lifestyle and climate with easy access to Philadelphia, New York City, Washington, D.C., the New Jersey Shore, Pocono resorts, and the Chesapeake Bay.

Send vita, transcripts, and three letters of recommendation (at least two of which attest to your teaching effectiveness) to:

Dr. Charles G. Denlinger
Search Committee Chairman, NT 11
Department of Math & Computer Science
Millersville University
Millersville, PA 17551

Interviews will begin about February 1, 1989. Millersville earnestly seeks applications from minority and women candidates. Millersville is an Affirmative Action/Equal Opportunity Employer.

Applications are invited for a tenure track position in mathematics beginning August 30, 1989. A doctorate with emphasis in any area of pure or applied mathematics or doctoral candidate in pure or applied mathematics with degree expected by September 1, 1989, is required. Commitment to quality teaching will be expected of all candidates. Candidates for this position will be expected to teach a wide variety of mathematics courses ranging from precalculus level courses to upper level courses in pure and/or applied mathematics. In addition to teaching, the person who fills this position will be required to work with other faculty members and students in curriculum development, student placement, and student advising. All applicants must be able to lawfully accept employment in the United States at the time of an offer of employment.

Appointments generally will be at the assistant professor level although in exceptional cases a more senior appointment is possible. Starting salary range is $24,000 to $33,000. For further information about the position contact Dr. Tom Richard, Department of Mathematics and Computer Science, Bemidji State University, Bemidji, MN 56601.

Submit letter of application, resume, official transcripts from all degree granting institutions, and three current letters of reference submitted directly by referrees to: Dr. Frank Saccoman, Dean of Science and Mathematics, Bemidji State University, Bemidji, MN 56601. The postmarked deadline is January 3, 1989, or until the position is filled. Bemidji State University is an equal opportunity educator and employer.

NOVEMBER 1988, VOLUME 35, NUMBER 9

1423
ANNOUNCEMENT OF VACANCY
Arizona State University
Department of Mathematics

The Department of Mathematics invites applications for tenure-track and visiting faculty positions at all ranks and in all areas of mathematics beginning in August of 1989. The Department is in the second year of a major development program intended to build nationally recognized research groups of four to seven faculty members in Computational Mathematics, Differential Equations (including PDE’s), Discrete Mathematics, Dynamical Systems, Operator Theory, Algebraic Geometry and Number Theory, Systems and Control, and Probability and Statistics.

For 1989, the majority of the tenure-track appointments will be made at the Assistant Professor level. To be considered for such an appointment, the candidate must demonstrate potential for outstanding research while providing effective teaching at both the undergraduate and graduate level in a public university environment. For candidates at the Associate Professor level, additional requirements include a proven record of outstanding research accomplishments and versatile and effective teaching. At the Full Professor level, applicants should be recognized nationally for the quality and scope of their research and leadership activities. Salaries are competitive and commensurate with experience and qualifications.

In support of its research and graduate education programs, the Department is installing in the Fall 1988 an Advanced Computing Facility centered around a network of Titan Mini-Super Graphics computers plus a cluster of Sun Work Stations. Research efforts will be further enhanced by direct access to the University’s CRAY XMP-14/se and IBM 3090-500E/2F super computers.

Arizona State University has over 43,000 students and is located in the rapidly growing Phoenix Metropolitan area—a center of business, finance and high technology. The valley offers a wide range of educational, cultural and recreational opportunities. Pleasant and convenient housing is widely available near the university campus.

Applications should be received by January 15, 1989. This deadline will be extended if all available positions are not filled. The Department will begin to review applications on January 1, 1989. Appointments will be made following final budgetary approval.

Applicants should send their resume and arrange for at least three letters of recommendation to be sent to: William T. Trotter, Chair, Department of Mathematics, Arizona State University, Tempe, AZ 85287-1804.

Arizona State University is an Equal Employment Opportunity/Affirmative Action Employer and does not discriminate on the basis of sex, race, religion, color, national origin, age, disabled or Vietnam-era veterans status, or disability in its admission, employment or educational programs or activities. Women and minorities are encouraged to apply.

McMASTER UNIVERSITY
BRITTON POST-DOCTORAL FELLOWSHIP
IN MATHEMATICS

Applications are invited for the Britton Post-Doctoral Fellowship in Mathematics.

Named after Dr. Ronald Britton, the Britton Fellowship is intended for talented, young research mathematicians who have recently completed the Ph.D. degree.

The Britton Fellowship is open to candidates of any nationality and selection will be based upon the candidate’s research potential. Preference will be given to candidates working in algebra, number theory, representation theory or algebraic K-theory.

The Britton Fellowship is tenable for a period of two years with effect from July 1, 1989, at a salary of $30,000 p.a. plus a research grant of $5,000.

Applications should be sent to:
Dr. I. Hambleton, Chairman
OR
V. P. Snaith, Sc.D., F.R.S.C.
Britton Professor of Mathematics
Department of Mathematics & Statistics
McMaster University
Hamilton, Ontario
Canada, L8S 4K1

THE UNIVERSITY OF TOLEDO

Applications are invited for one or more tenure track positions to be available beginning in September, 1989. Applicants should have a Ph.D., or have completed the Ph.D. by September, 1989, and be committed to both teaching and research. In addition, the department will have several visiting positions. Please send a resume and three letters of reference to Harvey Wolff, Chairman, Department of Mathematics, Toledo, Ohio 43606. The selection process will begin in early January, but applications will be accepted until the positions are filled. The University of Toledo is an equal opportunity, affirmative action employer.

WESTERN WASHINGTON UNIVERSITY

Applications are invited for tenure-track and visiting positions to begin Fall, 1989. A Ph.D. in Mathematics is required.

Candidates are especially sought in:
(1) Applied mathematics. Fields of particular interest are nonlinear differential equations, perhaps with a computational emphasis, dynamical systems, optimization and control theory.
(2) Mathematics Education. Responsibilities will include teaching upper division mathematics courses, mathematics methods courses, and the development of an active in-service program. Recent elementary/secondary teaching experience preferred.

Rank and salary are open, but a substantial research record will be required for appointments above the Assistant Professor level. The normal teaching load for research faculty is two courses per quarter.

Applications should be sent to Professor Thomas T. Read, Chairman, Department of Mathematics, Western Washington University, Bellingham, WA 98225

Interested candidates should submit a letter of application, complete transcripts, a vita, and three letters of recommendation. Deadline for applications is February 1, 1989; later applications will be considered if positions remain available. Positions are subject to the continuing availability of funds. The University is an EO/AA employer.
The Department of Mathematics, University of California, Santa Barbara, is planning to make a tenure-track assistant professor appointment in Algebra/Number Theory, effective July 1, 1989. Ph.D. required by the time of appointment. Preference will be given to applicants who have held the doctorate for at least two years. Evidence of excellence or potential for excellence in research and teaching required. Applicants should send their vita, publication list, and arrange to have three letters of recommendation on their research and one letter on their teaching sent to: Algebra Committee, Department of Mathematics, UC Santa Barbara, CA 93106, by January 15, 1989. Proof of U.S. citizenship or eligibility for U.S. employment will be required prior to employment (Immigration Reform and Control Act of 1986). Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF ARIZONA
DEPARTMENT OF MATHEMATICS
TUCSON, ARIZONA 85721

The Mathematics Department at the University of Arizona is happy to announce several postdoctoral fellowships (Research Associate) which will be available beginning August, '89. Applicants with areas of strength in applied mathematics, computational science and nonlinear optics may qualify for special Center of Excellence Awards. Only candidates with outstanding research records or potential should apply. Applications received before January 1, 1989, will be considered first; if suitable candidates are not found then late applications will be reviewed. Send applications to Department Head, Department of Mathematics. The University of Arizona is an Equal Opportunity/Affirmative Action Employer.

UNIVERSITY OF SOUTHERN CALIFORNIA
DEPARTMENT OF MATHEMATICS
LOS ANGELES, CALIFORNIA 90089-1113

Applications in any field of pure or applied mathematics are invited for several tenure-track Assistant professorships, beginning September, 1989, and for possible tenured positions at the ranks of Professor and Associate Professor. Visiting Professorships and Visiting Associate Professorships will also be available.

Assistant Professors are expected to teach two courses per semester and must show strong research promise. Applicants for senior positions must have an outstanding record of research and scholarly achievements.

Applications should be addressed to: Chairman, Search Committee, Department of Mathematics-350, University of Southern California, Los Angeles, CA 90089-1113.

U.S.C. is an Equal Opportunity/Affirmative Action employer.
Classified Advertisements

POSITIONS AVAILABLE

Temple University
Department of Mathematics
Assistant Professorship

The Mathematics Department expects to have, pending final budgetary approval, at least one tenure-track position at the junior level beginning Fall, 1989. Preferred specialties: Applied Math, Dynamical Systems, Algebra, Geometry. Outstanding research potential and serious commitment to teaching required. Competitive salaries and fringe benefits. Vita and three letters of reference should be sent by January 1, 1989 to Daniel Reich, Head, Search Committee, Box P, Department of Mathematics, Temple University, Philadelphia, PA 19122. Women and Minorities are especially encouraged to apply. Temple University is an Affirmative Action and Equal Opportunity Employer.

UNIVERSITY OF SOUTH CAROLINA
Department of Mathematics

Applications are invited for anticipated tenure-track faculty positions at all ranks. Applications in all areas of mathematics will be considered. The Department seeks to build on existing research strengths and to increase the scope of its programs, particularly in applied and computational mathematics. Faculty research is supported by excellent in-house library and computing facilities. The Department's computer center supports network access to the University's FPS array processor and 1.024 node hypercube supercomputer. The Ph.D. degree or its equivalent is required, and all appointments will be consistent with the Department's commitment to excellence in research and teaching at the undergraduate and graduate levels. A detailed resume, containing a summary of research accomplishments and goals, and four letters of recommendation should be sent to:

Dr. Colin Bennett, Chairman
Department of Mathematics
University of South Carolina
Columbia, South Carolina 29208

The University of South Carolina is an Affirmative Action/Equal Opportunity employer.

THE UNIVERSITY OF MICHIGAN–FLINT

A possible tenure track assistant professorship in Mathematics commencing Sept. 1, 1989. Ph.D. in Mathematics required. Department of ten with interests in algebra, algebraic geometry, classical and complex analysis, number theory, approximation theory and logic. UM-Flint is an urban regional campus of the University of Michigan. Enrollment is approximately 6000. Send vita and three letters of recommendation prior to Jan. 23, 1989, to Dr. K. E. Schilling, Department of Mathematics, UM-Flint, Flint, MI 48503, Ph. (313) 762-3314. Late applications considered until the position is filled. UM-Flint is an equal opportunity/affirmative action employer and encourages women and minorities to apply.

WEST VIRGINIA UNIVERSITY
EBERLY PROFESSORSHIP IN APPLIED MATHEMATICS

The Department of Mathematics invites applications and nominations for the EBERLY PROFESSORSHIP IN APPLIED MATHEMATICS. Candidates are sought who have outstanding scholarly accomplishments in applied mathematics, a record of funded research, and a commitment to instruction. The individual selected will be expected to provide academic leadership with continued excellence in these areas. The position will commence August, 1989. West Virginia University is the state's comprehensive, doctoral institution with a student enrollment over 18,000. The Mathematics Department, which has thirty faculty and thirty supported graduate students, offers programs leading to the BA, MS, and PhD degrees. Applications, nominations and inquiries should be directed to: James Lightbourne, Department of Mathematics, West Virginia University, Morgantown WV 26506. Candidates should submit a letter of application, vita, and names and addresses of five references. Review of applications will begin January 15, 1989, and continue until the position is filled. WVU is an Affirmative Action/Equal Opportunity Employer. Qualified women and minorities are encouraged to apply.

UNIVERSITY OF ARIZONA
DEPARTMENT OF MATHEMATICS
TUCSON, ARIZONA 85721

The Mathematics Department at the University of Arizona will have several visiting positions for next year. Applications received by February 1, 1989, will be considered first; if suitable candidates are not found then late applications will be reviewed. Send applications to Department Head, Department of Mathematics. The University of Arizona is an Equal Opportunity/Affirmative Action Employer.

California State University, Hayward

The Department of Mathematics and Computer Science is now seeking applicants for an entry level tenure track Assistant Professor position in mathematics beginning Fall, 1989.

Applicants should hold the Ph.D. degree in mathematics. Candidates should be committed to excellence in teaching, be willing and able to participate in curriculum development, and should exhibit the competence and potential to engage in significant professional activities, including research and publication. All areas of specialization will be considered, including mathematics education. The interests of the present faculty include a wide range of fields in mathematics and in computer science.

Interested applicants should send a resume and three references to:

Mathematics Faculty Search Committee
Department of Mathematics and Computer Science
California State University, Hayward
Hayward, CA 94542-3092

Applications received by January 1, 1989, will be assured full consideration. Applications will be accepted as long as positions remain available.

California State University, Hayward, an Equal Opportunity, Affirmative Action employer, seeks to create a stimulating atmosphere for its ethnically diverse student body and encourages applications from women and men of all ethnic backgrounds and physical abilities.
POSITIONS AVAILABLE

MEMPHIS STATE UNIVERSITY
DEPARTMENT OF MATHEMATICAL SCIENCES

The Department of Mathematical Sciences invites applications for anticipated tenure track positions for 1989. The department offers degrees at all levels including the Ph.D. and provides a very favorable research environment in terms of library and computing facilities (including a symbolic Intel Hypercube), teaching load, and travel opportunities. Preferred research areas in computer science include algorithms, parallel and distributed processing, artificial intelligence/cognitive science, software development, network design and analysis, data communications, and theory. Preferred research areas in statistics include time series, biostatistics, stochastic models, and applied statistics. Preferred research areas in computer science include algorithms, parallel and distributive processing, artificial intelligence/cognitive science, software development, network design and analysis, data communications, and theory. Preferred research areas in statistics include time series, biostatistics, stochastic models, and applied statistics.

Applicants must have a Ph.D. by September 1, 1989, and a strong potential for excellence in teaching and research. Selection will begin on February 10, 1989. Applications will continue to be accepted until all positions are filled. Women and Minorities are strongly urged to apply. Successful candidates must meet the Immigration Reform Act criteria of 1986. Applicants must submit a resume and direct three letters of reference to:

Ralph Faudree, Chair
Department of Mathematical Sciences
Memphis State University
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STOCKTON STATE COLLEGE

Tenure-track position in mathematics is available for January or September, 1989, at Assistant Professor or Instructor level. Ph.D. required for Assistant Professorship. A.B.D. required for Instructorship. Current salary range of $21,749-$30,404 may be higher in 1989-90. We seek an excellent, versatile teacher to be part of a strong, ten-person mathematics department in a young, liberal arts college in rural South Jersey. Area of specialty open, but interest in computer science a plus. Screening will begin on December 1, 1988. Send resume and three letters of reference to Dr. Donald Plank, Dean; Division of Natural Sciences and Mathematics; Stockton State College; Pomona, NJ 08240. Stockton is an AA/EO Employer. Women and minorities are encouraged to apply. R900823

BRADLEY UNIVERSITY. Department of Mathematics, Peoria, IL 61625. Jerome E. Hahn, Chairman. One, perhaps two, entry-level, tenure-track positions in mathematics beginning August 12, 1989, at the rank of Assistant Professor available. Ph.D. to be completed by August 12, 1989, required. Preference to candidates who will complement current research activities in the department (AL, FA, MO, TO). Salary competitive. Normal teaching load 12 hours per semester, reduced load for research possible. Continuing scholarly activity necessary for tenure. Closing date: January 13, 1989, or until the position is filled. Send letter of application, vita and three letters of recommendation to address above. AA/EOE.

DEPARTMENT OF MATHEMATICS
STANFORD UNIVERSITY

A tenure-track position in mathematics is available for Fall, 1989. Requirements: Ph.D., strong commitment to teaching; published research beyond the Ph.D. All mathematics research areas will be considered with special preference given to probability and statistics. Rank and salary commensurate with qualifications. The College of Staten Island is a senior college in CUNY. Send resume and three letters of reference to: Dr. Jane Coffee, Chairperson, Mathematics Department, College of Staten Island, 715 Ocean Terrace, Staten Island, N.Y. 10301 by January 31, 1989. AA/EOE employer.

College of Staten Island (CUNY)
Department of Mathematics

The department expects to make several tenure-track or tenured appointments beginning September, 1989, among the following fields: (1) analysis, (2) geometry or topology, (3) algebra, number theory, or logic, (4) applied mathematics or probability; in the last case there are also possibilities for joint appointments with other departments. At the tenured level, preference will go to individuals in the early years of their ranks, though a more senior appointment may be possible for an extremely well-qualified individual.

Candidates should send a letter of application and a curriculum vitae with a list of publications, and arrange to have three letters of recommendation and some evidence of commitment to excellence in teaching sent to Prof. Solomon Feferman, Chairman, Department of Mathematics, Stanford University, Stanford, CA 94305-2125, by January 1, 1989.

Stanford is an Equal Opportunity, Affirmative Action Employer, and welcomes applications from women and minorities.
**Positions Available**

The University of Georgia
Department of Mathematics
Athens, GA 30602

The department may have some tenure track positions available for the 1989-90 academic year at the assistant and associate professor levels. The rank and salary will be commensurate with the applicant's abilities and experience. The principal requirement is excellence in research and teaching. Some preference will be given to areas in which the department is already well represented. Send curriculum vitae and four letters of recommendation to Ray A. Kunze, Head (address above) by January 5, 1989. UGA is an Equal Opportunity/Affirmative Action Employer.

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**Georgia Institute of Technology**

The School of Mathematics expects to have available some visiting and tenure-track positions for Fall, 1989. These positions are in analysis, discrete and applied mathematics. The School is allied with the new Center for Dynamical Systems and Nonlinear Studies.

Candidates with strong teaching and research records or promise thereof are sought. In addition to a resume and references, candidates should send a summary of future research plans to The Search Committee, School of Mathematics, Georgia Institute of Technology, Atlanta, Georgia 30332-0160. Georgia Tech, a member of the University System of Georgia, is an Equal Opportunity/Affirmative Action Employer.

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The University of Maryland University College seeks excellent teachers for openings on U.S. military bases overseas. Appointments begin August, 1989. Requirements include M.A. or Ph.D., recent college teaching experience, and U.S. citizenship. Competence to teach in another discipline desirable. Benefits include transportation and military base privileges (PX, commissary, etc.). Frequent travel and the cost of schooling make these positions difficult for those with children. Send resume to Dr. Ralph E. Millis, Assistant to the President, Overseas Programs, The University of Maryland University College, College Park, MD 20742-1642. AA/EEO.

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**Rice University**

Department of Mathematics

Applications are invited for a tenure track assistant professorship. There is a possibility of an upgrade to associate or full professorship for an exceptional senior candidate. Candidates must have an extremely strong research background and good teaching skills. Preference will be given to applicants in low-dimensional topology, although outstanding candidates in analysis, geometry, and topology will also be considered.

Please send a curriculum vitae and at least 3 letters of recommendation to: Appointments Committee, Department of Mathematics, Rice University, P.O. Box 1892, Houston, Texas 77251.

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**Mississippi State University**

Department of Mathematics and Statistics

Applications are invited for two or more anticipated tenure-track positions for 1989-90. At least one of the positions will be in statistics and probably at least at the associate professor level. Candidates should possess a doctoral degree, demonstrate a strong potential for research, and have a commitment to effective teaching. All areas are welcomed but preference will be given to the following: for the mathematics position(s), applied mathematics, computational mathematics, and partial differential equations; for the statistics position(s), statistical computing, robust statistics, linear models, and multivariate analysis.

The Department offers graduate programs leading to the Master of Arts degree (M.A.) and the Master of Science degree (M.S.) in both mathematics and statistics and the Doctor of Philosophy degree (Ph.D.) in mathematical sciences. Facilities exist for applicants with interest in interdisciplinary research efforts and in particular for applicants with an interest in the computational aspects of the mathematical sciences.

Applicants should send a curriculum vitae and arrange for three letters of recommendation to be sent to: John R. Gilbert, Chairman, Search Committee, Department of Mathematics and Statistics, P.O. Drawer MA, Mississippi State, MS 35762. The committee will begin to review applications on January 15, 1989, and continue until positions are filled.

Mississippi State University is an equal opportunity/affirmative action employer.
Positions Available

Lycoming College

Department of Mathematical Sciences
Williamsport, PA 17701 Tel. 717-321-4239

Two entry-level tenure track positions, beginning August, 1989, in a seven member department offering majors in mathematics and computer science. Applicants should have: Ph.D. in mathematics or computer science; competency either to support the computer science major, or to support the mathematics education program (one-third load); a strong commitment to undergraduate teaching excellence. Interviewing at January Joint Meetings. Applications accepted until positions filled. Send resume, academic transcripts, and three letters of reference, with at least one addressing teaching, to David K. Haley, Chairman.

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SUNY, College at New Paltz

Computer Science Position

A tenure track Assistant Professorship is available for a PhD in Computer Science or related field with a Master’s or equivalent in Computer Science. Research interests of the department include functional programming, logic programming, neural networks, database design and formal languages. The College is located in the Hudson Valley-Catskill Mountains region of New York, known for its natural beauty and easy access to NYC. Send application and 3 recommendations attesting to teaching excellence and scholarly potential to: D. Clark, Chairman, Dept. of Mathematics and Computer Science, Box 10, SUNY, College at New Paltz, NY 12561. Review of applications will begin 12/1/88, pending funding approval. An AA/EOE. Women and minorities are urged to apply.

University of Kansas

Applications are invited for tenure-track and temporary positions at all levels, commencing August 16, 1989, or as negotiated. Field is unrestricted but preference will be given to numerical analysis and probability/statistics, and to areas meshing well with the department’s needs. Require Ph.D. or Ph.D. dissertation accepted with only formalities to be completed.

Application, detailed resume with description of research, and three recommendation letters should be sent to C. J. Himmelberg, Chairman, Department of Mathematics, University of Kansas, Lawrence, KS 66045-2142.

Deadlines: December 1, 1988, for first consideration, then monthly until August 1, 1989.

The University of Kansas is an AA/EOE.

Florida Atlantic University

Applications are invited for a senior level tenured appointment effective Fall, 1989. Rank and salary depend on qualifications. The candidate should have a nationally or internationally distinguished research record and demonstrated excellence in teaching. Applications will be accepted until February 1, 1989. Send vita and arrange for three letters of recommendation to be sent to Prof. F. E. Schroek, Jr., Chairman, Search Committee, Department of Mathematics, Florida Atlantic University, Boca Raton, FL 33431. Florida Atlantic University is an Equal Opportunity/Affirmative Action Employer. Women and minorities are encouraged to apply.

University of Wisconsin-Milwaukee

Department of Mathematical Sciences

Applications are invited for several anticipated tenure-track assistant professorships beginning Fall, 1989. We especially seek candidates in

i) applied mathematics and/or numerical analysis,

ii) applied analysis and/or dynamical systems,

iii) topology,

iv) complex variables,

v) statistics.

Candidates should have proven ability or demonstrated potential for research as well as good teaching qualifications. Duties for the positions consist of research and teaching two courses per semester. Please send credentials and at least three letters of recommendation by January 27, 1989, to Search Committee, Department of Mathematical Sciences, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, WI 53201.

The University of Wisconsin-Milwaukee is an affirmative action/equal opportunity employer.
The Department of Mathematics & Statistics, McMaster University, invites applications for a tenure track Assistant Professorship starting July 1, 1989. Candidates should have a Ph.D. and proven research ability in some area of Mathematics related to Analysis, as well as capability in teaching. Salary based on qualifications and experience. This position is subject to final budgetary approval.

Please send curriculum vitae and arrange for three letters of reference to:
I. Hambleton, Chairman
Mathematics & Statistics
McMaster University
Hamilton, Ontario
L8S 4K1 Canada

FURMAN UNIVERSITY
Greenville, South Carolina 29613

One tenure track position in mathematics beginning September, 1989. A Ph.D. in a mathematical science is required. Excellence in teaching and continued scholarly activity are expected. Rank and salary will be based on qualifications. All areas of specialization are acceptable. Vita, graduate and undergraduate transcripts, and three letters of recommendation should be sent to Dr. Robert Fray, Department of Mathematics. Application deadline: February 1, 1989. EOE/AAE

MATHEMATICS DEPARTMENT, UNIVERSITY OF CALIFORNIA, SANTA CRUZ, CA 95064

The Mathematics Department at the University of California, Santa Cruz expects to have several visiting positions available during the academic year 1989-90 and invites applications from qualified mathematicians in all fields. Appointments will be made as Visiting Assistant, Associate or Full Professor, as appropriate. Such positions are available for periods ranging from one quarter to two years. There is a possibility that three-year visiting positions at the level of beginning Assistant Professor will be available. Preference will be given to those who can teach for at least the entire academic year. Applicants must hold the Ph.D. in Mathematics. University eaching experience desired. Applicants should send vita, three letters of reference speaking to the applicant's research and teaching experience to: Recruiting Committee, Mathematics Department, University of California, Santa Cruz, CA 95064. Closing Date: February 1, 1989. Please refer to #T88-13 in your reply. UCSC IS AN EEO/AA/IRCA EMPLOYER

DEPARTMENT OF MATHEMATICS
THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

A number of appointments are expected for Fall, 1989, at all levels, including Instructor (customarily appointees are new PhDs), Assistant Professor (customarily appointees have at least two years experience beyond the PhD), Associate Professor, and Professor. Candidates should have outstanding research ability and concern for teaching. Salaries are competitive. Please send vita, detailed summary of research interests, and three recommendation letters to address above as follows:
Instructor and Assistant Professor:
c/o Recruiting Committee

Associate Professor and Professor:
c/o John Dollard, Chairman

The University of Texas at Austin is an equal opportunity employer. Minorities and women are encouraged to apply.

CONCORDIA UNIVERSITY
DEPARTMENT OF MATHEMATICS AND STATISTICS

The Department of Mathematics and Statistics at Concordia University is seeking to fill a tenure track position in pure mathematics (subject to budgetary approval) starting June 1, 1989, at a level to be determined.

Applications should be sent to:
Dr. W. P. Byers, Chairman
Department of Mathematics and Statistics
Concordia University
7141 Sherbrooke St. W.
Montreal, Que., Canada
H4B 1R6

Please include a statement of research interests together with your current C.V. and arrange for 3 letters of reference to be forwarded. All applications will be considered, but in accordance with Canadian immigration requirements, preference will be given to Canadian citizens and permanent residents. The deadline for receipt of completed applications is November 30, 1988.

CHARLES B. MORREY JR. ASSISTANT PROFESSORSHIPS
Department of Mathematics
University of California at Berkeley
Berkeley, CA 94720

We invite applications for these special two-year (non-tenure-track) positions effective July 1, 1989. Applicants should have a recent Ph.D. in the areas of algebra, analysis, applied mathematics, foundations, or geometry and topology, and should have demonstrated superior research potential. Send by January 15, 1989, a curriculum vitae and reprints, preprints and/or a dissertation abstract. Ask three people to send letters of recommendation to Marc A. Rieffel, Vice Chair for Faculty Affairs, at the above address. The University of California is an Equal Opportunity, Affirmative Action Employer.

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MATHEMATICS

STATE UNIVERSITY OF NEW YORK
AT BUFFALO

The Department of Mathematics anticipates the appointment of at least one tenured or tenure-track faculty member beginning September 1, 1989. Salary will be competitive. Outstanding applicants in all fields of mathematics are encouraged to apply. We seek applicants with excellent research accomplishments/potential and a strong commitment to teaching.

Applicants should send any supporting information and have four letters of recommendation sent to:

Dr. Nicolas Goodman
Search Committee Chairman
Department of Mathematics
SUNY/Buffalo
106 Diefendorf Hall
Buffalo, New York 14214

The deadline for applications is December 1, 1988. Late applications will be considered until positions are filled.

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NOVEMBER 1988, VOLUME 35, NUMBER 9
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Card Number

Card Expiration Date __________________ Signature __________________

<table>
<thead>
<tr>
<th>Shipping and Handling</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Book</td>
</tr>
<tr>
<td>Surface</td>
</tr>
<tr>
<td>Air</td>
</tr>
</tbody>
</table>

Prices are subject to change without notice.

Books are sent via surface mail (UPS to U.S. addresses and printed matter elsewhere) unless air delivery is requested. The shipping and handling charges for book orders are shown in the table. Journal back numbers, Mathematical Reviews indexes and review volumes are sent via surface mail to any destination unless air delivery is requested. Postage for surface mail is paid by the AMS. Air delivery rates, which will be quoted upon request, must be paid by the purchaser. Software: Nonindividual customers need not prepay provided a Purchase Order number is given with the order. Software/books are sent via UPS to U.S. addresses, first class mail to Canada, and air delivery elsewhere. Add shipping and handling for Software/Books: $6 per order in the U.S. and Canada; $25 per order air delivery outside the U.S. and Canada.

Customers in these areas should request price information from and direct their orders to the following distributors:

- **Europe/Middle East/Africa**: Barry Emms, Clarke Association, Unit 2, Pool Rd., Trading Estate, West Molesey, Surrey KT8 0HE, England. Tel. 01-941-6966, Telex 298210 XOEAN G; exclusive distributor of AMS books.
- **Japan**: Maruzen Co. Ltd., P.O. Box 5050, Tokyo International 100-31, Japan. Tel. Tokyo 272-7211, Telex J26516
- **India**: Allied Publishers Pvt. Ltd., 15, J. N. Herdia Marg., Ballard Estate, Bombay 400038, India
Change of Address

Members of the Society who move or who change positions are urged to notify the Providence Office as soon as possible.

Journal mailing lists must be printed four to six weeks before the issue date. Therefore, in order to avoid disruption of service, members are requested to provide the required notice well in advance.

Besides mailing addresses for members, the Society’s records contain information about members’ positions and their employers (for publication in the Combined Membership List). In addition, the AMS maintains records of members’ honors, awards, and information on Society service. Information of the latter kind appears regularly in Notices.

When changing their addresses, members are urged to cooperate by supplying the information requested below. The Society’s records are of value only to the extent that they are current and accurate.

If your address has changed, or will change within the next two or three months, please place the peel-off label from the back cover (which contains your name, member code, and address) in the rectangle provided below (or on a copy of this page), supply any other information appropriate for the AMS records, and mail to the address given below.

Place Notices label here

Change effective as of: ________________________________

New mailing address: __________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________

New position: ________________________________________________

If mailing address is not that of your employer, please supply the following information:

New employer: ________________________________________________

Location of employer: ____________________________

<table>
<thead>
<tr>
<th>City</th>
<th>State/Province</th>
<th>Country</th>
<th>Zip Code</th>
</tr>
</thead>
</table>

Recent honors and awards: __________________________________________
________________________________________________________________
________________________________________________________________

Personal items for publication in Notices: ____________________________
________________________________________________________________
________________________________________________________________

Mail completed form to:

Membership Department, AMS, P.O. Box 6248, Providence, RI 02940
NOTE: This is not an AMS Short Course Form. Please use the Joint Meetings Registration/Housing Form to preregister for the AMS Short Course.

To register for MAA Minicourse(s) and/or Workshop, please complete THIS FORM or a PHOTOCOPY OF THIS FORM and return it with your payment to:

Minicourse: Susan Wilderson  
Mathematical Association of America  
1529 Eighteenth Street, N.W.  
Washington, DC 20036  
Telephone: 202-387-5200

Workshop: Alicia Bennett  
Mathematical Association of America  
1529 Eighteenth Street, N.W.  
Washington, DC 20036  
Telephone: 202-387-5200

(Please print)  
Surname First Middle  
Telephone:  
Street address City State Zip

- Deadline for MAA Minicourse and Workshop preregistration: November 10, 1988  
- Deadline for cancellation in order to receive a 50% refund: December 30, 1988 (No refunds after this date)  
- Registration for the Joint Meetings is a requirement in order to participate in the MAA Minicourses and/or Workshop. Complete the Preregistration/Housing Form included in the meeting announcement and return it to Providence with the applicable Joint Meetings preregistration fee. DO NOT SEND MAA MINICOURSE/WORKSHOP FORM OR FEES TO PROVIDENCE.  
- Each participant must fill out a separate Minicourse form.  
- Enrollment is limited to two Minicourses, subject to availability.  
- Please complete the following and send both form and payment to Susan Wilderson OR Alicia Bennett at the above address:

  I would like to attend □ 1 Minicourse □ 2 Minicourses □ Workshop on Teaching Assistants and Part-Time Instructors  
  Please enroll me in MAA Minicourse(s): #-- and #-- In order of preference, my alternatives are: #-- and #--  
  For my two workshop discussion groups, my preferences are (please list three or more) #-- #-- #-- #-- #--  

- PAYMENT  
  Check enclosed: $_______  
  Credit card type: □ MasterCard □ Visa  
  Credit card #________________________ Expiration date:______________

Your Employing Institution  
Organized by  
Fee

Minicourse Number and Name  
Organized by:

1. Computer graphics in elementary statistics
2. Using computer graphing to enhance the teaching and learning of calculus and precalculus mathematics
3. Using history in teaching calculus
4. Applications of discrete mathematics
5. Writing in mathematics courses
6. Surreal numbers
7. Computer based discrete mathematics
8. Teaching mathematical modeling
9. Learning math through discrete dynamical systems
10. Applied mathematics via classroom experiments
11. Modeling with the Poisson process
12. muMATH workshop
13. Applications of the HP28S supercalculator for more experienced users
14. Creating order out of chaos in freshman mathematics: instituting a mathematics placement program
15. Ada for mathematicians

Workshop on Teaching Assistants and Part-Time Instructors: Responses to the Challenge  
Organized by: Bettye Anne Case  
Fee: $15

Discussion group choices:
A. Administrative support for programs  
B. Lecture/recitation and multi-section formats  
C. Part-time instructors at two- and four-year colleges  
D. Academic concerns of TAS  
E. International TA concerns  
F. TAS in master’s-only departments  
G. University-wide TA training programs  
H. Departmental TA training

☐ I plan on preregistering for the Joint Meetings only in order to attend the MAA Minicourse(s) and/or TA/PTI Workshop indicated above. It is my understanding that, should the course(s) of my choice be filled, full refund of the Joint Meetings preregistration fee will be made.
The tradition of the International Congress of Mathematicians began in Zurich, Switzerland in 1897. Since then, the Congress has been held every four years, except during the first and second world wars. In a time when increasing specialization has divided mathematics into many subfields, ICM serves an important role. Its purpose is to foster personal relationships between mathematicians from different countries and to present a survey of the current state of mathematical research. In addition, the Congress has provided the occasion for awarding the prestigious Fields Medals and Nevanlinna Prize.

In August 1986, more than 3500 mathematicians gathered in Berkeley, California for the nineteenth ICM. These proceedings, printed in two volumes, represent a complete account of the activities of the Berkeley Congress. Volume 1 contains the official record of the ICM, the list of members, presentations made on the work of the Fields medalists and the Nevanlinna Prize winner, and the 15 one-hour plenary session addresses. More than 140 45-minute invited lectures were given, and these have been grouped into 19 mathematical sections which are listed below. Those addresses from sections 1-8 appear in Volume 1, with the remaining 11 sections in Volume 2. More than 400 short communications were presented at ICM, and the names of the communicators and the titles of their papers appear in the proceedings.

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Instructions for Applicant's Form

The form. Applicants' forms submitted for the Employment Register will be photographically reproduced in the December 1988 issue of Employment Information in the Mathematical Sciences. Résumés of those attending will be posted at the meeting.

The forms must be carefully typed using a fresh black ribbon. The best results are obtained with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained using a ribbon made of nylon or other woven fabric if suitable care is exercised. It is important that the keys be clean and make a sharp, clear impression. Do not erase—it causes smudges which reproduce when photographed. Use a correcting typewriter or correction tape or fluid if necessary. Submit the original typed version only. Copies will not reproduce properly and are not acceptable. Hand lettered forms will be returned.

Applicants' forms must be received by the Society by November 10, 1988 in order to appear in the special issue of EIMS, and must be accompanied by the Preregistration/Housing Form printed in this issue, if attending the meeting. Forms received past the deadline or not completed will be returned.

The summary strip. Information provided here will be used to prepare a printed list of applicants for distribution to employers. Please supply all information requested, and confine your characters to the boxes provided. Use the codes below. Circled letters identify corresponding items on the form and the strip.

A Specialties

AL = Algebra
AN = Analysis
BI = Biomathematics
BS = Biostatistics
CB = Combinatorics
CM = Communication
CN = Control
CS = Computer Science
CT = Circuits
DE = Differential Equations
EC = Economics
ED = Mathematical Education
FA = Functional Analysis
FI = Financial Mathematics
FL = Fluid Mechanics
GE = Geometry
HM = History of Math
LO = Logic
MB = Mathematical Biology
ME = Mechanics
MO = Modelling
MP = Mathematical Physics
MS = Management Science
NA = Numerical Analysis
NT = Number Theory
OR = Operations Research
PR = Probability
SA = Systems Analysis
ST = Statistics
TO = Topology

B Career Objectives

AR = Academic Research
AT = Academic Teaching
NR = Nonacademic R&D
NC = Nonacad. Consulting
NS = Nonacademic Supervision

D Duties

T = Teaching
G = Graduate
C = Consulting
S = Supervision
GOV = Government
U = Undergraduate
R = Research
A = Administration
IND = Industry
DP = Data Processing

Location

E = East
C = Central
W = West
S = South
M = Mountain
O = Outside U.S.
I = Indifferent

U.S. Citizenship Status

C = U.S. Citizen
P = Permanent Resident
T = Temporarily in U.S.
N = Non-U.S. Citizen
**MATHEMATICAL SCIENCES EMPLOYMENT REGISTER**

**APPLICANT FORM**

**JANUARY 11-13, 1989**

**PHOENIX, ARIZONA**

The form must be typed. (Please see instructions on facing page)

---

**APPLICANT:**

Name: __________________________________________________________

Mailing address (include zip code) __________________________________________

---

A Specialties

B Career objectives and accomplishments

ACADEMIC: [ ] Research, [ ] Teaching

NON-ACADEMIC: [ ] Research and Development, [ ] Consulting, [ ] Supervision

Near-term career goals: ____________________________________________

---

Significant achievements or projects, including role: ______________________

---

Honors and offices: ________________________________________________

Other (e.g., paper to be presented at THIS meeting): ______________________

---

Selected titles of papers, reports, books, patents: ______________________

---

C Degree Year Institution

---

D No. of abstracts, internal reports

---

E No. of papers accepted

---

F No. of books and patents

---

**EMPLOYMENT HISTORY:**

<table>
<thead>
<tr>
<th>Present</th>
<th>Previous</th>
<th>Previous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employer:</td>
<td>Position</td>
<td>Duties</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**DESIRED POSITION:**

- Duties: __________________________________________________________

- Available mo. /yr: Location: Salary: ________________________________

---

**REFERENCES**

(Name and Institution)

---

I do not plan to attend the Winter Meeting [ ]

---

**AVAILABLE FOR INTERVIEWS:**

(Interviews for Session 4 scheduled on the basis of employer's request only.)

<table>
<thead>
<tr>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
<th>Session 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thurs. AM 9:30-11:45</td>
<td>Thurs. PM 1:15-5:00</td>
<td>Fri. AM 9:30-11:45</td>
<td>Fri. PM 1:15-5:00</td>
</tr>
</tbody>
</table>

---

**SUMMARY STRIP**

<table>
<thead>
<tr>
<th>Family Name</th>
<th>First Name</th>
<th>Mailing Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

---

- Address (cont’d.): [ ]

- State & Zip Code: [ ] [ ]

- Specialties: [ ] [ ] [ ] [ ] [ ]

---

- Career objectives: [ ] [ ] [ ]

- Highest Degree Yr: Institution: [ ] [ ] [ ] [ ]

---

- Present duties: [ ] [ ] [ ]

- Desired duties: [ ] [ ] [ ]

- Available mo./yr: [ ]

---

- Sessions: [ ] [ ] [ ] [ ]
EMPLOYER FORM  

**INSTRUCTIONS:** Please read carefully before completing form below. Circled letters identify corresponding items in the FORM and the SUMMARY STRIP; abbreviations to be used are provided in the notes below. Please print or type in black ink. Block capitals are suggested. The FORM itself will be placed on display at the Register exactly as submitted. The SUMMARY STRIP (be sure to complete) will be used to prepare a computer printed list of summaries for distribution at the Register sessions. Employers are encouraged to provide more than one interviewer when they are able to do so, in order to increase the number of interviews which may be scheduled. Please take care to indicate on the Form the number of interviewers for whom simultaneous interviews may be scheduled. (If all interviewers will be interviewing for the same position, or for the same set of positions, only one form should be submitted and only one employer code number will be assigned; therefore, each interviewer would then receive a separate computer schedule and a separate table number.) More than one employer code will be required if some interviewers will not interview for all positions. Thus, if there are two disjoint sets of positions, two forms are required and two employer codes will be assigned. (Please refer to the section on the Employment Register following the Phoenix meeting announcement.)

<table>
<thead>
<tr>
<th>Name of Interviewer(s)</th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
</tr>
</thead>
</table>

City, State, Zip

<table>
<thead>
<tr>
<th>Title(s) of Position(s)</th>
<th>Number of Positions</th>
<th>Number of People Supervised</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Salary</th>
<th>Term of Appointment</th>
<th>Renewal</th>
<th>Possible</th>
<th>Tenure Track Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>mo.</td>
<td>yr.</td>
<td>yrs.</td>
<td>( )</td>
<td>( )</td>
<td>( )</td>
</tr>
</tbody>
</table>

Teaching hrs./week  

<table>
<thead>
<tr>
<th>Specialties Sought</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Degree Preferred</th>
<th>Degree Accepted</th>
<th>Duties</th>
<th>Experience</th>
<th>Citizenship Restriction</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Available for Interviews</th>
<th>Session 1 ( )</th>
<th>Session 2 ( )</th>
<th>Session 3 ( )</th>
<th>Session 4 ( )*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thurs AM</td>
<td>9:30-11:45</td>
<td>Thurs PM</td>
<td>1:15-5:00</td>
<td>Fri AM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Interviewers:</th>
<th>Interviewers</th>
<th>Interviewers</th>
<th>Interviewers</th>
<th>Interviewers</th>
</tr>
</thead>
</table>

**NOTES:**  
- Inst, Lect, Asst Prof, Ass Prof, Prof, Dean, Open, MTS (Member Technical Staff), OPAN (Operations Analyst), PREN (Project Engineer), RESC (Research Scientist);  
- Date 01/89, e.g.;  
- Possible=P, Impossible=I;  
- Bachelor=B, Master=M, Doctor=D;  
- Teaching=T, Undergraduate=U, Graduate=G, Research=R, Consulting=C, Administration=A, Supervision=S, Industry=IND, Government=GOV, Date Processing=DP, No Experience=NE;  
- U.S. Citizen=C, U.S. Citizen or permanent resident=CP, No restriction=NR;  
- Periods available for interviews: List 1, 2, 3, and/or 4, see the FORM above.  
* Interviews are scheduled in this session on the basis of employers request only.
Preregistration/Housing Form, Phoenix, Arizona
January 11–14, 1989

Must Be Received in Providence No Later Than November 10, 1988

Please complete this form and return it with your payment to
Mathematics Meetings Housing Bureau
P.O. Box 6887, Providence, Rhode Island 02940 – Telephone: (401) 272-9500, Ext. 290-Telex: 707192

DEADLINES:

<table>
<thead>
<tr>
<th>Event</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room Lottery Qualification</td>
<td>October 31, 1988</td>
</tr>
<tr>
<td>Preregistration/Housing Form</td>
<td>November 10, 1988</td>
</tr>
<tr>
<td>Housing Changes/Cancellations</td>
<td>December 14, 1988</td>
</tr>
<tr>
<td>Preregistration Changes/Cancels</td>
<td>December 30, 1988</td>
</tr>
</tbody>
</table>
| 50% Refund on Preregistration/Banquet/Hike | December 30, 1988 (no refunds after this date)

REGISTRATION FEES

<table>
<thead>
<tr>
<th>Event</th>
<th>Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preregistration by mail by</td>
<td>$63</td>
</tr>
<tr>
<td>November 10, 1988</td>
<td>$82</td>
</tr>
<tr>
<td>At Meeting</td>
<td></td>
</tr>
<tr>
<td>Joint Meetings</td>
<td></td>
</tr>
<tr>
<td>Member of AMS, CMS, MAA, NCTM, SMM</td>
<td>$63</td>
</tr>
<tr>
<td>Nonmember</td>
<td>$98</td>
</tr>
<tr>
<td>* Student, Unemployed, or Emeritus</td>
<td>$18</td>
</tr>
<tr>
<td>AMS SHORT COURSE</td>
<td></td>
</tr>
<tr>
<td>Member/Nonmember</td>
<td>$40</td>
</tr>
<tr>
<td>* Student or Unemployed</td>
<td>$15</td>
</tr>
<tr>
<td>EMPLOYMENT REGISTER</td>
<td></td>
</tr>
<tr>
<td>Employer fee (1st Interviewer)</td>
<td>$75</td>
</tr>
<tr>
<td>Employer fee (2nd / 3rd Interviewer)</td>
<td>$35</td>
</tr>
<tr>
<td>Applicant fee</td>
<td>$15</td>
</tr>
<tr>
<td>Posting fee for job descriptions for noninterviewing employers</td>
<td>$10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Joint Meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMS Short Course (January 10–11, 1989)</td>
</tr>
<tr>
<td>Employer</td>
</tr>
<tr>
<td>Applicant</td>
</tr>
<tr>
<td>Posting</td>
</tr>
</tbody>
</table>

1) (Please print) Surname First Middle Telephone: __________________________

2) (Mailing address)


4) I am a student at ____________________________________________________________ 5) Emeritus member [ ] Unemployed [ ]

6) Accompanied by spouse ___________________________________________ Number of children ___________________________ (Enumerate only if accompanying to meeting)

7) Member of AMS [ ] CMS [ ] MAA [ ] NCTM [ ] SMM [ ] Nonmember [ ] (Member discount applies only to members of AMS, CMS, MAA, NCTM, and SMM) Member of other organizations: AWM [ ] NAM [ ] MR Classification #

8) Joint Meetings fee $ __________ 9) AMS Short course fee $ __________ 10) Employer fee(s) $ __________ 11) Co-Interviewer fee(s) $ __________

12) Applicant fee $ __________ 13) Posting fee $ __________ 14) Hotel deposit $ __________ (necessary ONLY if paying deposit by check)

15) _________ AMS 25-Year Banquet ticket(s) @ $25 each = $ _________ Desert Hike ticket(s) @ $10 each = $ _________

17) TOTAL AMOUNT ENCLOSED FOR 8 through 16 $ __________ NOTE: May be paid by check payable to AMS (Canadian checks must be marked “U.S. Funds”) or VISA or MasterCard credit cards.

Credit card type: ____________________________ Card number: ____________________________ Expiration date: __________

If this is your credit card, please print your name as it appears on the credit card on the line below as well as sign your name.

If this is not your credit card, please print card holder’s name as it appears on the credit card on the line below, and have the card holder sign:

( ) PLEASE CHECK HERE IF YOU WILL NOT REQUIRE A ROOM

( ) PLEASE CHECK HERE IF YOU WILL BE STAYING AT A HOTEL/MOTEL NOT LISTED ON THE REVERSE

Please complete the appropriate sections on the reverse if you will require hotel accommodations.

For office use only:

<table>
<thead>
<tr>
<th>Codes:</th>
<th>Options:</th>
<th>Hotel:</th>
<th>Room type:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dates:</td>
<td>Hotel Deposit</td>
<td>Total Amt. Paid:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Remarks:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please rank hotels in order of preference by writing 1, 2, 3, etc. in the spaces at the left on form, and by circling the requested room type and rate. If the rate requested is no longer available, you will be assigned a room at another hotel at the next available rate. If not all hotels are ranked, and all rooms have been filled at the ranked hotels, the assignment will be made at an unranked hotel with the next available rate. Rates listed below are subject to 9.1% sales/occupancy tax.

GUARANTEE REQUIREMENTS: $50 by check OR a credit card guarantee with VISA, MasterCard, or American Express (for housing only). No other credit cards will be accepted. PLEASE SUPPLY THIS INFORMATION ON THE REVERSE, together with mailing address for confirmation of room reservation.

<table>
<thead>
<tr>
<th>Order of choice</th>
<th>Single</th>
<th>Double</th>
<th>Twin</th>
<th>Triple double</th>
<th>2 beds</th>
<th>2 beds w/cot</th>
<th>Quad 2 beds</th>
<th>2 beds w/cot</th>
<th>Suite</th>
<th>$</th>
<th>$</th>
<th>$</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyatt Regency Phoenix (Headquarters Hotel)</td>
<td>73</td>
<td>73</td>
<td>73</td>
<td>83</td>
<td>93</td>
<td>93</td>
<td>103</td>
<td></td>
<td></td>
<td>200</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sheraton Phoenix</td>
<td>75</td>
<td>75</td>
<td>75</td>
<td>85</td>
<td>95</td>
<td>95</td>
<td>105</td>
<td></td>
<td></td>
<td>225</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holiday Inn-Financial Center</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>69</td>
<td>N/A</td>
<td>79</td>
<td>N/A</td>
<td></td>
<td></td>
<td>Upon</td>
<td>Request</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holiday Inn-Airport East</td>
<td>59</td>
<td>59</td>
<td>59</td>
<td>69</td>
<td>N/A</td>
<td>69</td>
<td>N/A</td>
<td></td>
<td></td>
<td>Upon</td>
<td>Request</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days Inn San Carlos</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>51</td>
<td>60</td>
<td>57</td>
<td>66</td>
<td></td>
<td></td>
<td>Upon</td>
<td>Request</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Special housing requests: ___________________________________________________________

I will arrive on (date) __________________________ at __________________________ a.m./p.m., and depart on (date) __________________________ at __________________________ a.m./p.m.

Please list other room occupants; indicating ages of children.

<table>
<thead>
<tr>
<th>FULL NAME</th>
<th>ARRIVAL DATE</th>
<th>DEPARTURE DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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