

FOCUS

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Zero-Knowledge Proofs

Joe Buhler

Suppose that you have discovered a proof of your favorite open problem (e.g. Fermat's Last Theorem). Suppose that you want to convince someone else beyond a shadow of a doubt that you have a proof without giving the slightest clue as to what your proof is.

This seems impossible, and yet it is exactly what Manuel Blum, of the Computer Science Department at the University of California at Berkeley, showed how to do at the International Congress of Mathematicians this August. His ideas build on the work of a number of other people and are the latest evidence of the continuing ferment in the common ground between cryptography, computational complexity, and related areas of mathematics.

Blum gives a method that will convince a skeptical verifier that the prover has found a proof while not revealing anything about the proof. The idea of such *zero-knowledge* proofs was formalized last year by Shafi Goldwasser, Silvio Micali, and Charles Rackoff; they were motivated by questions in computational complexity. Oden Goldreich, Silvio Micali, and Avi Wigderson showed earlier this year that an important class of theorems (affirmative instance of NP-complete problems) had zero-knowledge proofs. Blum then showed that this could be extended to *any* mathematical theorem. These ideas also play a role in recent work of Amos Fiat and Adi Shamir that provides secure cryptographic identification schemes.

These schemes or protocols are *interactive*. For instance, in Blum's scheme there is a dialogue between the prover and the verifier similar to a conversation in a classroom or seminar in which a mathematician explains a proof, except that at the end the audience is convinced that the prover has a proof while knowing nothing at all about it except for having an upper bound on the length of the proof. This may occasionally approximate the state of affairs in seminars, but this is coincidental; the idea of a zero-knowledge proof is a striking way to present a new idea whose applications may have substantial impact in cryptography and computational complexity.

A simple example illustrates some of the ideas in Blum's scheme. Suppose that Alice (A) presents Bob (B) with two integers X and N and asserts that she knows a square root

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Conference at UCLA on the Effects of Standardized Tests on Mathematics Education

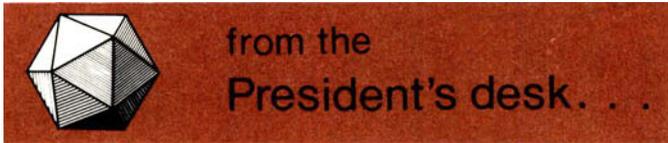
Linda Rosen

American students take standardized tests almost from entry into kindergarten through completion of graduate training. The perception that such tests inhibit changes and improvements in education motivated an invitational conference titled "The Influence of Testing on Mathematics Education", sponsored by the Mathematical Sciences Education Board (MSEB) of the National Research Council and the Center for Academic Interinstitutional Programs (CAIP) of the University of California at Los Angeles held June 27-28, 1986. Over eighty people attended the meeting; they represented various groups from the educational community including developers of standardized tests, textbook publishers and editors, the PTA, state and local school administrators, state mathematics supervisors and superintendents, research mathematicians, educators at the university, community college, elementary and secondary levels, and professional educational groups.

The conference brought together the information and advice needed to help plan research on testing that MSEB will undertake supported by the National Science Foundation. The first day was spent discussing the impact of current testing programs and describing the best-case scenario for the future of testing in mathematics education. The topics were covered in plenary sessions, each with two speakers followed by an open forum among participants. The primary speakers were Thomas Romberg, Wisconsin Center for Education Research; Tej Pandey, California Assessment Program in the State Department of Education; Beverly Anderson, Education Commission of the States; and Ann McAloon, Educational Testing Service.

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Annual Meeting Program in Center Section. Changes listed on page 4.



Lynn Arthur Steen, St. Olaf College

The One-Third World

Data recently released from the 1985 CBMS survey of undergraduate mathematics shows that nearly one-third of all undergraduate enrollments in mathematical sciences are in the two year colleges. Nearly 20% of those college students who take calculus and statistics do so in two year colleges, as do nearly two-thirds of those taking remedial courses.

However, only 25% of college mathematics faculty are in two year colleges, and only 5% of the Ph.D. faculty. Indeed, 40% of two year college faculty members do not attend any professional meetings, nor read any professional journals.

Overloaded and often undervalued, faculty at two year colleges carry the ideal of equal opportunity for American higher education. Other countries can match our colleges and universities in selecting and educating the ablest students. But nowhere else can one find such a broad-based system of entry and re-entry to higher education than that provided by America's two year institutions. Their graduates range from technicians who fill industrial needs to leading mathematicians such as MIT professor Kenneth Hoffman, who reports regularly on these pages as Director for Federal Relations for the entire mathematical community.

The MAA has a long tradition of promoting the interests of two year college mathematics, a tradition shaped by active two year faculty working in leadership positions within the Association. In 1974, the Association took over publication of the fledgling *Two Year College Mathematics Journal* and nurtured it into the most popular mathematical periodical in the world devoted to the mathematics of the first two college years. A few years later the Association introduced mini-courses at its national meetings designed especially for those who teach beginning college mathematics. These courses are now immensely popular, and draw as well from four year college and university faculty as from two year college faculty.

Overall, these activities have provided MAA's nearly 2000 two year college members with rich opportunities for professional growth, both as learners and as leaders within the community. The increasing support for two year college activities within the Association has been led—often sharply prodded—by a succession of active two year college leaders. Recently, the Board of Governors approved a proposed change in the Bylaws to elevate the role of Second Vice President to a nationally-elected office, thereby giving all Association members opportunity to vote for a leader from the two year college community.

The CBMS data makes clear that two year faculty have a great need for professionally enriching activities, and at the same time have comparatively little opportunity or incentive for such work. Some signs, however, suggest that this Catch-22 environment may be changing. In the past five years—during a period of essentially stable enrollments—workloads at two year colleges decline by 12% as new faculty were added. During this same period, professional activity reported by the faculty increased by 15-20%.

These are good signs of salutary trends. Concerning workload, MAA can do little more than encourage enlightened leaders at many two year institutions to continue their support for faculty. But concerning professional development,

we can and are doing much more: MAA offers a wide variety of opportunities in publications, meetings, public information, and leadership positions to insure that two year faculty, as all faculty, can maintain currency with the rapidly changing face of the contemporary mathematical sciences. Two-year-college issues are a crucial component in the national agenda for renewal of collegiate mathematics, and MAA intends to press these issues with vigor in the years ahead.

Applied Math Contest To Be Held February 1987

The third Mathematical Competition in Modeling (MCM) will be held on college campuses the weekend of 6th February 1987. Announcements of this undergraduate contest will be mailed to mathematics department chairmen and previous MCM advisors in early October.

As in the MCM 1986 contest, each three-student team will choose one of two problems and will have a weekend to work on it. The team may use reference works and computers. The problems will be realistic, and thus do not have unique or "packaged" solutions. Analysis and design are important, and partial solutions are acceptable. It is expected that in 1987 about 150 three-student teams will enter.

Interested MAA members can learn more about this contest from a special issue of the journal *Mathematical Modeling* published by Pergamon Press or by writing or calling the Project Director, B.A. Fusaro, Mathematical Sciences, Salisbury State College, Salisbury, MD, 21801; (301) 543-6470. The exemplary solutions published in *Mathematical Modeling* will be sent to all advisors who register a team in 1987 in order to give an idea of the best in student work in applied mathematics.

Early Deadline for NSF/CBMS Regional Conference Proposals

The deadline for 1988 conference proposals has been moved to April 1, 1987. This was done in response to suggestions from participants in order to give a longer lead time for the lecturers. This regional program has been stimulating research for over fifteen years and has sponsored just short of 200 conferences. It offers an unusual opportunity for lecturers to draw together important and productive new methods and results and present these to an ideal audience—first at the conference itself, and then, to the broader research audience, by a promptly published monograph.

By way of encouragement to potential lecturers or sponsors, the Conference Board of the Mathematical Sciences (CBMS) offers the following words from Joel Spencer. These were sent to CBMS soon after Spencer gave his lectures on probabilistic methods in the summer of 1986 and shortly before he submitted the manuscript for his monograph: "I hadn't realized how much fun the whole thing would be. Giving a lecture to an audience that includes Bill Lucas, Tom Trotter, the Vazirani brothers—just to name a few—is a real charge. . . . I have been chugging away on the lecture notes. . . ."

Twenty copies of the completed proposals should be sent to the Data Support Service Section, National Science Foundation, 1800 G Street, N.W., Washington, DC 20550. These proposals must follow CBMS guidelines which can be obtained from: CBMS, 1529 18th Street, N.W., Washington, DC 20036, telephone (202) 293-1170. Ralph Krause is the program officer at NSF and Peter Renz is the administrative officer at CBMS.

A Hot Summer for Mathematics

Kathleen Holmay

During July and August mathematics was the hottest topic covered by science reporters across the country. The coverage began when the U.S. team to the International Mathematics Olympiad tied with Russia for first place. The six returning team members were met at Kennedy Airport by a reporter and photographer from the *New York Times*. The next day they were interviewed by United Press International.

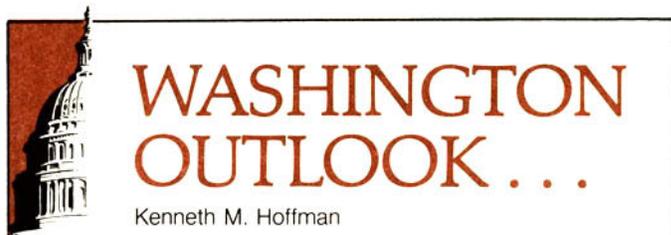
Next came an impressive front page *Science Times* story (*New York Times*, August 5) featuring a session at the SIAM July 21 Press Briefing.

Then an embarrassment of media riches stemming from ICM 86 and mathematics in general followed in early August. A series of articles in major daily newspapers and significant specialty publications dispelled once and for all an idea prevalent among mathematicians, as well as among some media representatives—that mathematics is “impossible to cover”.

An early and conservative estimate indicates that our collected clippings over the last 2 months reached about 10 million people, many of whom are involved in government, public policy and higher education.

Why the sudden barrage? First, we had a series of newsworthy events, activities that allowed us to highlight people and their work in mathematics. Second, we have been making media overtures—distributing news releases, mailing copies of testimony, giving away subscriptions to various publications in mathematics, calling and meeting reporters and editors, etc.—in a concentrated fashion for about nine months. Hence, mathematics was fresh in the minds of key reporters. Third, we have been building momentum in addition to conveying that we are in the public information business for the long haul. We haven't expected quick coverage. Instead, we have been listening to reporters and methodically responding to their individual needs. We have also set the mathematics stage, so to speak, with activities like Math Awareness Week in April. Fourth, we took advantage of the cumulative effect of the Olympiad, the SIAM Press Briefing, ICM 86 and other events, such as the AAAS exhibit of fractal art. No one event would have been as significant without the support of the others. And joint efforts within each event, such as the ICM Public Information Committee working together with the U.C. Berkeley Public Information Office, worked in the same manner to give us a larger impact than we otherwise would have realized.

So, what are our priorities at this point, now that we have passed the introductory public information phase? The newly formed Public Information Resource Committee is emerging as an important group both as a source for story ideas and as a source of individuals who can effectively communicate with non-mathematicians. Increasing the involvement of this group with on-going public information activities is mandatory. Plus, further work with reporters is necessary. We will continue giving usable information to the reporters who **know** mathematics and we will be expanding that number with several initiatives designed to introduce other reporters to the excitement, relevance and creativity of mathematics.



The NSF Budget: A Rocky Road Through Congress

Over the summer, while most of the nation's scientific community was concentrating on research, traveling to the start of another academic year, a tense melodrama was being played out in Washington which could seriously affect the amount of basic research done in this country in the next decade or more, and seriously affect the efforts of our community to restore its research funding to a state of health. The focus of the debate: Congressional appropriations for the National Science Foundation (NSF) in FY 1987, the year which began October 1, 1986.

The president's budget, submitted last January, had asked for \$1.7 billion for NSF, an increase of about 12% over total FY 1986 spending levels, and an increase of 14% in NSF's basic research budget. The administration's rationale: Basic research is an investment in the future and must be maintained even in these very tight financial times; furthermore, the FY 1986 spending level for NSF was actually less than in FY 1985, since Congress provided a 4% increase from '85 to '86 and then took away 4.8% in the first round of the Gramm-Rudman-Hollings budget reductions—mathematics fared much better, in part because it was exempted from the effects of Gramm-Rudman by request of Dr. Erich Bloch, Director of the NSF.

The president's budget for NSF went through the authorization process in the House Appropriations Committee (more specifically, it's HUD-Independent Agencies Subcommittee) effectively, wiped out all of the \$185 million increase for basic research which the budget contained, by reducing that increase to a pathetic \$39 million. The full House subsequently passed an appropriations bill which set NSF spending levels for research about 3% above FY 1986, rather than the 14% which had been requested.

Not surprisingly, the actions in the House set in motion a flurry of activity by the Washington representatives of the scientific community. The target: The Senate Appropriations Subcommittee on HUD-Independent Agencies. The objective: Persuade them to set their appropriation for NSF as close as possible to the \$1.7 billion level authorized. The early feedback from the Subcommittee was discouraging, as key members seemed to be leaning in the direction of the House thinking. Efforts to persuade them otherwise were intensified.

Those efforts lasted for weeks and were ultimately successful. On September 18, the Subcommittee voted for the full 14% increase for research at NSF.

One positive note with a consistent ring through all these proceedings was that both the House and Senate appropriations added \$10 million to the \$89 million request for Science Education at NSF.

For the situation as of September 18, see the box on NSF budgeting trends on the next page.

NATIONAL SCIENCE FOUNDATION BUDGETARY TRENDS (\$ in millions)

	FY85 Actual	FY86 Plan	FY87 Request	FY87 House	FY87 Senate
Research	1301M	1294M	1479M	1333M	1479M
Science Ed.	87M	85M	89M	99M	99M
Other*	113M	111M	118M	118M	118M
NSF Total	1502M	1490M	1686M	1550M	1696M

*The "other" is primarily the Antarctic program.

In the latter half of September, the pace really picked up. The targets: Both House and Senate Appropriations Subcommittees on HUD-Independent Agencies. The objective: Persuade them that the Senate version should prevail when they go to conference; that is, don't be satisfied with splitting the difference—rather, try to persuade all the conferees that the higher appropriation is necessary.

Part of the intensity of the pace was that Congress was hard at work, cleaning up seemingly a million odds and ends, headed toward adjournment in the first week of October. In an election year, adjournment comes in time for the members to go home for the last few weeks of the campaign. Their motivation for "getting things settled" is to ensure that they get home *and* will not be called back for a lame duck session late in the year, after the elections.

As this article goes to press, the outcome is still unknown, but it appears likely that "splitting the difference" will win out, leaving the Science Education Directorate of NSF with an 11% increase in its budget and the Research Directorate with an increase of 7%.

In Memoriam

William Frederick Eberlein, Professor Emeritus, University of Rochester, died June 13, 1986, at the age of 68. He was an MAA member for 39 years.

Lou Green, Case Western Reserve University, retired, died September 24, 1986. He was an MAA member.

Ferdinand Hagel, Long Branch Board of Education, died August 1986, at the age of 45. He was an MAA member.

Howard Jackson, McMaster University, died January 1986. He was an MAA member for 15 years.

Terry McAdam, Washburn University of Topeka, died June 15, 1986. He was an MAA member for 31 years.

David Pickard, Queen's University, died July 1986, at the age of 41. He was an MAA member for 2 years.

Harvey Tung, Wayne County City College, retired, died May 1986, at the age of 64. He was an MAA member for 2 years.

James H. Wilkinson, Chief Scientific Officer, National Physical Laboratory, Teddington, U.K., died recently. He was an MAA member.

Program Changes for the January Annual Meeting

Josiah Willard Gibbs Lecture

The title of the Gibbs lecture to be presented by THOMAS G. SPENCER is *Schrödinger operators and dynamical systems*.

Other MAA Sessions

There will be a panel on *Approval voting* on Saturday, January 24, from 2:15 p.m. to 3:30 p.m. The moderator is PHILLIP D. STRAFFIN, JR., Beloit College. Speakers are STEVEN J. BRAMS, New York University, and SAMUEL MERRILL, III, Wilkes College and Yale University.

The session on *The leading edge of software*, being organized by WARREN PAGE, has been moved to Thursday, January 22, from 7:30 p.m. to 9:30 p.m. Speakers include THOMAS BANCHEFF, Brown University. *The educational differential geometry environment (EDGE)*; HARRY LEWIS, Harvard University, *Computer graphics for teaching and learning multi-variable calculus*; and JUDAH L. SCHWARTZ, Massachusetts Institute of Technology and Harvard University, *Fostering conjectures and exploration in Euclidean geometry*. For further information contact the session organizer, Warren Page, New York City Technical College, 300 Jay Street, Brooklyn, New York 11201.

The name of the organizer of the presentation on *The mathematical competition in modeling (MCM)* on Thursday, January 22, at 2:15 p.m. was incorrectly given in the October issue. The correct name is BERNARD A. FUSARO.

MAA FILMS

The program for the MAA films is as follows:

7:30 p.m.—*Fly Lorenz*

7:50 p.m.—*Planar double pendulum*

8:25 p.m.—*On size and shape: Overview*

9:00 p.m.—*The impossible dream: Election theory*

Activities of Other Organizations

The days and times of the program for the Association for Women in Mathematics have changed as follows:

The seventh annual Emmy Noether Lecture has moved to 9:00 a.m. on Thursday, January 22.

The panel discussion on *Responses to the David Report: Initiatives for women and minorities* has been moved to Wednesday, January 21 at 3:20 p.m.

The AWM Business Meeting will be held at 4:20 p.m. on Wednesday, January 21.

A reception being planned by AWM will be held at 9:30 p.m. on Wednesday, January 21.

The name of the speaker in the National Meeting of Department Heads on Thursday, January 22, at 7:30 p.m. who will be speaking on *Master's degrees in the mathematical sciences for small schools* was incorrectly given in the October issue. The correct name is BERNARD A. FUSARO.

AMS-MAA Symposium

The AMS-MAA Symposium on *The role of mathematicians in pre-college education* has been changed to begin at 7:30 p.m. on Thursday, January 22. An additional speaker is LARRY HATFIELD, University of Georgia.

January 21-24, 1987



SAN ANTONIO

70th ANNUAL MEETING OF THE MATHEMATICAL ASSOCIATION OF AMERICA

The January 1987 Joint Mathematics Meetings, including the 70th Annual Meeting of the Mathematical Association of America, the 93rd Annual Meeting of the American Mathematical Society, and the 1987 annual meetings of the Association for Symbolic Logic, Association for Women in Mathematics and the National Association for Mathematicians, will be held January 21 - 24 (Wednesday - Saturday), 1987, in San Antonio, Texas. Sessions will take place in the San Antonio Convention Center and the San Antonio Marriott Hotel.

70th Annual Meeting of the MAA January 21 - 24, 1987

Invited Addresses

There will be seven invited fifty-minute addresses. The names of the speakers, their affiliations, the dates and times of their talks, and the titles follow:

Steven J. Brams, New York University, *Game theory, nuclear deterrence, and Star Wars*, 2:15 p.m. Friday;

Andy deSessa, University of California, Berkeley, *Artificial worlds and real mathematics*, 3:20 p.m. Wednesday;

Daniel H. Gottlieb, Purdue University, *Algebraic topology and robots*, 2:15 p.m. Wednesday;

Richard K. Guy, University of Calgary, *The strong law of small numbers*, 10:05 a.m. Saturday;

Peter D. Lax, Courant Institute of Mathematical Sciences, New York University, *Euclidean/ non-Euclidean wave equation*, 9:00 a.m. Saturday;

Frank T. Leighton, Massachusetts Institute of Technology, *Networks, parallel computation, and VLSI*, 9:00 a.m. Thursday;

John W. Milnor, Institute for Advanced Study, *Self-similarity and hairiness in the Mandelbrot set*, 10:05 a.m. Thursday.

Minicourses (Application Form page xix)

Fifteen Minicourses are being offered by the MAA. The names and affiliations of the organizers, the topics, the dates and times of their meetings, and the enrollment limitations of each are as follows:

Minicourse #1: *A microcomputer linear algebra course using LIN-KIT* is being organized by Howard Anton. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Wednesday, January 21, and Part B from 2:15 p.m. to 4:15 p.m. on Thursday, January 22. Enrollment is limited to 30.

LIN-KIT is a powerful microcomputer package which can do linear algebra operations in either exact rational arithmetic (without the distraction of round-off error) or floating point arithmetic (facilitating study of computational aspects). Its data storage and retrieval capabilities lend themselves to self-paced courses.

The Minicourse will consist of (1) a "hands-on" session on the use of LIN-KIT, (2) a problem-solving session, making application of LIN-KIT, (3) a session on design of courses to meet various needs, and (4) a summary session devoted to discussion and perhaps design of a new computer-based linear algebra course. Microcomputers will be used extensively by participants, but prior experience is **not** required.

Minicourse #2: *Introduction to computer graphics* is being organized by Joan P. Wyzkoski, Fairfield University. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Wednesday, January 21, and Part B from 2:15 p.m. to 4:15 p.m. on Thursday, January 22. Enrollment is limited to 30.

Graphs and illustrations of geometrical objects are useful tools in the teaching of mathematics. Computer graphics simplifies the production of these teaching aids. This Minicourse will present some of the mathematical techniques used to produce realistic pictures on graphics display devices. Some of the topics to be discussed are

curve and surface sketching, 2D and 3D transformations, perspective drawing, and hidden line removal. Suggestions will be given for the use of these techniques to complement mathematics instruction. Since personal computers will be available for demonstrations and in-class implementations, programming experience is necessary.

Minicourse #3: *The teaching of applied mathematics* is being organized by W. Gilbert Strang, Massachusetts Institute of Technology. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Wednesday, January 21, and Part B from 2:15 p.m. to 4:15 p.m. on Thursday, January 22. Enrollment is limited to 80.

The organizer will discuss one possible framework for an introduction to modern applied mathematics. After basic courses in calculus and linear algebra, there is an important need that is not met by the traditional advanced calculus. The course should include both discrete and continuous problems, and numerical and combinatorial algorithms, bringing out their analogies and developing the mathematical ideas that are shared by different applications. The organizer is convinced that this syllabus is also the right way to organize the mathematics needed by engineers and computer scientists; that subject does not have to be old-fashioned and boring. Topics from several areas will be presented exemplifying this unifying approach. Participants will be invited to discuss effective ways to teach applied mathematics.

Minicourse #4: *Interesting applications of elementary mathematics* is being organized by JoAnne S. Growney, Bloomsburg University. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Friday, January 23, and Part B from 7:00 p.m. to 9:00 p.m. on Friday, January 23. Enrollment is limited to 40.

Students with modest mathematical backgrounds often are unaware of the ways that the arithmetic and logic that they already know can be used in many ways: to organize and understand information, to make decisions, and to solve problems. This Minicourse will introduce to participants a variety of interesting and significant applications that can be used in "general education" courses designed to develop mathematics appreciation and quantitative reasoning skills in students in the humanities and other non-quantitative fields.

Mathematical topics will be presented in the context of solving particular problems. Problem types to be considered include: organizing information, scheduling time, individual decision making, group decision making, achieving a goal, analysis of a fad, and simulation.

Treatment of topics will include strategies for development of student skills in divergent thinking and evaluation as well as convergent thinking (problem solving). Lists of references for further reading will be supplied.

Minicourse #5: *Discrete mathematics using difference equations* is being organized by James T. Sandefur, Jr., Georgetown University. Part A is scheduled from 4:30 p.m. to 6:30 p.m. on Wednesday, January 21, and Part B from 7:00 p.m. to 9:00 p.m. on Thursday, January 22. Enrollment is limited to 30.

Difference equations provide a non-standard structure to discrete mathematics, permitting standard topics such as linear algebra and probability to be interspersed with interesting models including Markov processes and predator-prey relationships. The Minicourse will intro-

duce both linear and nonlinear difference equations and provide illustrative applications of each. Microcomputers will be used to calculate solutions for mathematical models and generate graphical output. Prior programming experience is **not** required.

Minicourse #6: *Using microcomputer software in teaching calculus* is being organized by David A. Smith, Benedict College and David P. Kraines, Duke University. Part A is scheduled from 4:30 p.m. to 6:30 p.m. on Wednesday, January 21, and Part B from 7:00 p.m. to 9:00 p.m. on Thursday, January 22. Enrollment is limited to 30.

Selected IBM-compatible commercial software packages will be demonstrated, and ways to use them in teaching and supplementing traditional calculus courses will be presented. Participants will have "hands-on" use of the selected materials. Handouts will provide information about other calculus materials available for IBM, Apple II series, and Macintosh computers.

There is no Minicourse #7.

Minicourse #8: *Computer simulation of discrete systems* is being organized by Zaven A. Karian, Denison University. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Friday, January 23, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, January 24. Enrollment is limited to 30.

Computer simulations are particularly useful in situations where: (a) complete mathematical formulation of a problem is not possible or available; (b) available analytic methods require simplifying assumptions which distort the true nature of the problem; (c) available methods are so complex that they become impractical; (d) it is too complex or too expensive to conduct real-world experiments; (e) it is necessary to change the time scale to study the dynamics of a system.

The objective of this course is to provide an understanding of the design, implementation, and analysis of discrete-event computer simulations. The emphasis will be on the computational issues associated with the implementation of simulations through GPSS and/or SIMSCRIPT II.5, the two most widely used discrete-event simulation programming languages. In the second session, there will be an opportunity to work with some models on IBM-PC compatible systems using these languages.

Minicourse #9: *Recurrence relations* is being organized by Margaret Barry Cozzens, Northeastern University. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Friday, January 23, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, January 24. Enrollment is limited to 30.

Problems where the behavior of a system can be expressed in terms of the behavior of a system at a previous stage or time can often be solved using a recurrence relation. In addition, recurrence relations are used to model population growth, heating and cooling, radioactive decay, the spread of information and disease, and the time to run computer algorithms. This Minicourse will show how recurrence relations can be included in the curriculum of a wide variety of courses, from advanced high school courses, to finite math courses, to calculus, and to discrete structures courses. It will show how models based on recurrence relations lead in a natural way to

models based on differential equations, and therefore can and should be integrated in calculus courses.

Microcomputers will be available to enhance the understanding of recurrence relations and the problems studied.

Minicourse #10: *Integrating history into undergraduate mathematics courses* is being organized by Judith V. Grabiner, Pitzer College. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Friday, January 23, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, January 24. Enrollment is limited to 50.

The history of mathematics can help us teach students to understand mathematical ideas better by understanding how those ideas actually came to be. This Minicourse will take an in-depth look at two examples from the calculus: the calculus as algorithm, and the foundations of the calculus. It will include careful study of selections from the work of men like Fermat, Leibniz, Newton, and Cauchy. Brief accounts (and supporting materials) for other examples, from probability and statistics and from computer science, will be touched on as well. Finally, guidance will be given on how to learn more, what materials are most helpful, and how to develop other examples on one's own.

Minicourse #11: *Teaching mathematical modeling* is being organized by Frank R. Giordano, U.S. Military Academy and Maurice D. Weir, Naval Postgraduate School. Part A is scheduled from 9:00 a.m. to 10:55 a.m. on Friday, January 23, and Part B from 1:00 p.m. to 3:00 p.m. on Saturday, January 24. An optional third session, Part C, will use the microcomputer facility and is scheduled from 3:30 p.m. to 5:30 p.m. on Saturday, January 24. Enrollment is limited to 40.

The MAA Committee on the Undergraduate Program in Mathematics recommended in 1981 that "Students should have an opportunity to undertake 'real world' mathematical modeling projects..." as part of the common core curriculum for all mathematical science majors. This because many applications of problems in science, industry, and government are best approached using mathematical modeling techniques.

This Minicourse provides an introduction to the modeling process, to several topics underlying the construction of mathematical models and addresses issues related to the design of an undergraduate course in modeling.

The optional third session will consist of demonstrations and "hands-on" running of models on microcomputers.

Minicourse #12: *True BASIC in freshman calculus* is being organized by James F. Hurley, University of Connecticut. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 23, and Part B from 3:30 p.m. to 5:30 p.m. on Saturday, January 24. Enrollment is limited to 30. Prerequisite: none, although some familiarity with BASIC would be helpful.

Microcomputers can significantly enrich introductory calculus in a number of ways. This Minicourse will illustrate one such way, which uses a powerful, fully structured version of BASIC developed at Dartmouth by the inventors of BASIC, John Kemeny and Thomas Kurtz. Writing programs in this language can both teach precise, logical thinking akin to that needed to construct proofs and also provide impressive concrete illustrations of basic mathe-

matical concepts. Participants will experience the ease of use and power of True BASIC by entering and running several simple programs designed for student creation, and will also use programs that numerically illustrate limits, differentiation, implicit differentiation, optimization, root approximation, integration, sequences, series, Taylor polynomials, and numerical solution of differential equations. Considerable attention will be devoted to True BASIC's machine-independent graphics, which afford easy plotting of functions, parametric equations, and polar coordinate equations.

Minicourse #13: *For all practical purposes* is being organized by Solomon A. Garfunkel, COMAP, Inc. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 23, and Part B from 3:30 p.m. to 5:30 p.m. on Saturday, January 24. Enrollment is limited to 40.

This course deals with introducing contemporary applications throughout the undergraduate curriculum. Materials presented will include tapes from the soon-to-be-released PBS telecourse *For all practical purposes* as well as print modules from the UMAP series. Applications will cover a wide variety of fields with special emphasis on discrete mathematics and applications to management science and decision making.

Minicourse #14: *Applications of discrete mathematics* is being organized by Fred Stephen Roberts, Rutgers University. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 23, and Part B from 3:30 p.m. to 5:30 p.m. on Saturday, January 24. Enrollment is limited to 60.

One of the reasons that discrete mathematics has become so important is the enormous variety of applications of the subject. This Minicourse will explore these applications. The emphasis will be on several simple and traditional discrete techniques: basic counting rules of combinatorics, the principle of inclusion and exclusion, the notion of graph coloring, and the concept of eulerian path. These techniques will be quickly reviewed (though prior knowledge of combinatorics or graph theory will not be necessary). Applications will include switching functions in computer science, DNA chains in genetics, power in simple games in economics and political science, scheduling and operations research, engineering problems involving telecommunications and mobile radio transmission, urban sciences, computer graph plotting of electrical networks, and keypunching errors in computing.

Minicourse #15: *Constructing placement examinations* is being organized by John W. Kenelly, Clemson University. Part A is scheduled from 7:00 p.m. to 9:00 p.m. on Friday, January 23, and Part B from 3:30 p.m. to 5:30 p.m. on Saturday, January 24. Enrollment is limited to 40.

Lectures and workshops will take participants, step-by-step, through the entire process of constructing and implementing placement exams, including: preliminary planning, writing test items, designing a test for establishing cut-off scores, and evaluating the test. Placement testing problems of participants' own institutions will be discussed during question and answer periods.

Participants interested in attending any of the Minicourses should complete the Minicourse Preregistration Form and send it directly to the MAA Office at the address given on the form so as to arrive prior to the

November 15 deadline. DO NOT SEND THIS FORM TO PROVIDENCE. (Registration Forms page xix)

The Minicourses are open only to persons who have registered for the Joint Mathematics Meetings and paid the Joint Meetings registration fee.

If the only reason for registering for the Joint Meetings is to gain admission to a Minicourse, this should be indicated by checking the appropriate box on the Minicourse Preregistration Form. Then, if the Minicourse is fully subscribed, full refund can be made of the Joint Mathematics Meetings preregistration fee. Otherwise, the Joint Meetings preregistration will be processed, and then be subject to the 50 percent refund rule. PREREGISTRATION FORMS FOR THE JOINT MEETINGS SHOULD BE MAILED TO PROVIDENCE PRIOR TO THE DEADLINE OF NOVEMBER 15.

The registration fee for Minicourses #1, #2, #5, #6, #8, #9, and #12 is \$35 each. The registration fee for the other Minicourses is \$25 each.

Contributed Papers

Contributed papers were accepted on five topics in collegiate mathematics. The topics, organizers, their affiliations, and days they will meet are:

- *Remedial mathematics: Issues and innovations*, Geoffrey R. Akst, Borough Manhattan Community College CUNY, Friday morning.
- *The history of mathematics*, Duane Blumberg, University of Southwestern Louisiana, Thursday afternoon.
- *New methods of teaching calculus*, Wade Ellis, Jr., West Valley College, San Jose, Wednesday morning.
- *Experiences with computer support for service courses*, Carol Jones, University of Houston-Downtown, Wednesday morning.
- *Retaining and recruiting undergraduate women in mathematics courses: Aspirations and experiences*, Patricia C. Kenschaft, Montclair State College, Saturday afternoon.

The deadline for submitting papers for these sessions was **September 30. Late papers will not be accepted.**

Other MAA Sessions

MAA-NCTM Panel Discussion

A panel discussion on *Reform in mathematics education* is being jointly sponsored by the MAA and the National Council of Teachers of Mathematics (NCTM); it is scheduled from 9:00 a.m. to 10:55 a.m. on Wednesday, January 21. The moderator is John Dossey, president of NCTM, and the panel members are Donald L. Chambers, Department of Public Instruction (Madison, WI); F. Joe Crosswhite, past-president of NCTM; Paul Foerster, Alamo Heights High School (San Antonio); Carol Greenes, Boston University; Shirley A. Hill, Mathematical Sciences Education Board; and Jack Price, Palos Verdes Peninsula School District (Rolling Hills, CA).

Software Session

A session on *The leading edge of software* has been organized by Warren Page, New York City Technical College (CUNY). The session is scheduled from 8:30 a.m. to 10:55 a.m. on Wednesday, January 21.

Two-Year College Reception

The Committee on Two-Year Colleges is sponsoring an informal reception for two-year college faculty from 4:30 p.m. to 6:00 p.m. on Wednesday, January 21.

The Mathematical Competition in Modeling

Benjamin A. Fusaro, Salisbury State College, has organized a presentation on *The mathematical competition in modeling (MCM)* from 2:15 p.m. to 4:15 p.m. on Thursday, January 22. Introductory remarks by the organizer will be followed by three winning solution papers from the contest, which will be presented by the winning student teams.

ICME-6 Panel Discussion

A panel discussion titled *Post-secondary mathematics at ICME-6: What are the major issues?* is scheduled from 2:15 p.m. to 3:45 p.m. on Thursday, January 22. The organizers are John M. Mack, University of Sydney, and Lynn A. Steen, St. Olaf College. The purpose of this session is to obtain "an American perspective," identifying the issues most needing debate in 1988 on mathematics education in colleges and universities.

MAA-ACM-IEEE Panel Discussion

The Joint MAA-ACM-IEEE Task Force on Teaching Computer Science in Mathematics Departments is sponsoring a panel discussion in order to exchange views with members of MAA. This panel is organized by Zaven A. Karian, Denison University, and is scheduled from 2:15 p.m. to 4:00 p.m. on Thursday, January 22. Three members of the Task Force will make brief statements and the remaining time will be devoted to an open discussion.

Mathematics as a Humanistic Discipline

Alvin White, Harvey Mudd College, is organizing a session on *Mathematics as a humanistic discipline* which is scheduled from 8:00 a.m. to 10:55 a.m. on Friday, January 23. Participants will include the organizer; Donald W. Bushaw, Washington State University; Ubiratan D'Ambrosio, Univ Estadual de Campinas (Brazil); Philip J. Davis, Brown University; A. Gardiner, University of Birmingham (England); Shirley A. Hill, Mathematical Sciences Education Board; Anneli Lax, Courant Institute of Mathematical Sciences, New York University; David B. Meredith, San Francisco State University; Robert Osserman, Stanford University; Frances A. Rosamond, Ithaca; and Sherman K. Stein, University of California, Davis.

CCIME Panel Discussion

The Committee on Computers in Mathematics Education (CCIME) is sponsoring a panel discussion on *The use of computers in teaching differential equations*. The panel will be chaired by Howard Lewis Penn, U.S. Naval Academy, and is scheduled from 9:00 a.m. to 10:30 a.m. on Friday, January 23.

Project 2061 Mathematics Panel

The *Mathematics panel report of AAAS Project 2061* is scheduled from 2:15 p.m. to 4:15 p.m. on Saturday, January 24. Among the panelists will be Leon Henkin, University of California, Berkeley.

Statistics Presentation

There will be a presentation titled *Working with statistics: Statistical process control (SPC) techniques* from 2:15 p.m. to 4:15 p.m. on Saturday, January 24. Speakers will include Barbara Ashley and Analisa L. France, Jefferson Community College (Louisville, KY). The presentation will give an overview of the ways in which elementary statistics are being used to improve quality in business and industry.

Prize Session and Business Meeting

The MAA Prize Session is scheduled from 3:20 p.m. to 4:30 p.m. on Friday, January 23. The Chauvenet Prize, the Award for Distinguished Service to Mathematics, and six Certificates of Meritorious Service will be presented. The 1986 Carl B. Allendoerfer, Lester R. Ford, and George Pólya Awards for expository writing will also be presented.

The Business Meeting of the MAA will take place at 4:40 p.m. following the Prize Session. Some bylaw changes will be submitted for membership approval. This meeting is open to all members of the Association.

Board of Governors

The MAA Board of Governors will meet at 9:00 a.m. on Tuesday, January 20. This meeting is open to all members of the Association.

Section Officers

There will be a Section Officers' meeting at 7:00 p.m. on Tuesday, January 20.

Films

The MAA Film Program will take place on Friday, January 23, at 7:30 p.m. The program will include the films *Planar double pendulum* and *Fly Lorenz*.

93rd Annual Meeting of the AMS January 21 – 24, 1987

The American Mathematical Society (AMS) program will feature a series of four Colloquium Lectures presented by Peter D. Lax. The sixtieth Josiah Willard Gibbs Lecture will be given by Thomas C. Spencer. There will be seven one-hour invited addresses given by Marc Culler, Rutgers University; Ronald J. DiPerna, University of California, Berkeley; Richard T. Durrett, Cornell University; Robert M. Hardt, University of Minnesota, Minneapolis; Robert J. McEliece, California Institute of Technology; David J. Saltman, University of Texas at Austin; and Lesley M. Sibner, Polytechnic Institute of New York.

The American Mathematical Society will also present a short course entitled *Moments in Mathematics* on Tuesday – Thursday, January 20 – 22. The program is being coordinated by Henry Landau, AT&T Bell Laboratories.

Joint AMS – MAA Sessions

AMS-MAA Invited Addresses

By invitation of the AMS-MAA Joint Program Committee, (Judith V. Grabiner, chairman, Paul R. Halmos, F. Reese Harvey, and W. Gilbert Strang), two speakers will address the joint meeting of the AMS and MAA on the history and development of mathematics. The names of the speakers,

their affiliations, the titles, dates, and times of their talks follow:

Edward N. Lorenz, Massachusetts Institute of Technology, *Strange attractors: Are they still strange?*, 11:10 a.m. Friday.

Uta C. Merzbach, National Museum of American History, *Algebraic traditions on two continents*, 11:10 a.m. Thursday.

AMS-MAA Symposium

The AMS and MAA are cosponsoring a symposium on *The role of mathematicians in pre-college education* at 7:00 p.m. on Thursday, January 22. This symposium has been organized by Philip Wagreich of the University of Illinois at Chicago. Speakers include C. Herbert Clemens, University of Utah; Leon Henkin, University of California, Berkeley; Harvey Keynes, University of Minnesota, Minneapolis; Paul J. Sally, Jr., University of Chicago; and Philip Wagreich. This symposium will deal with various questions related to the involvement of mathematicians in pre-college education. Does it benefit education? How does it affect mathematicians? How to get financial support? Is there moral and financial support from mathematics departments? Is it possible to be involved in pre-college education and continue to do research in mathematics? Members of the panel will give brief presentations describing projects with which they are involved. Open discussion will follow.

AMS-MAA-MSEB Forum on the K-12 Curriculum

Over the next two decades, the nation's schools must make a dramatic transition in their mathematics programs, with emphasis shifting from drill in paper-and-pencil computations to experience in using the conceptual, analytical, and problem-solving techniques of mathematics. This transition will involve fundamental changes in content, modes of instruction, teacher education, and methods of assessing student progress. The impact on collegiate mathematics will be substantial. In this forum, members of the Mathematical Sciences Education Board of the National Research Council will present their current thinking about how to bring about the transition, and will seek reactions and advice from the forum's participants. Individuals intending to participate in the forum may wish to review materials on the K-12 curriculum prepared by MSEB. To obtain these materials in advance of the forum, contact: MSEB, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418; 202-334-3294. Copies will also be available at the forum, which will take place at 9:30 a.m. on Friday, January 23.

AMS-MAA Workshop

The AMS and MAA are cosponsoring a workshop at 4:30 p.m. on Wednesday, January 21. This workshop is being organized by Joel Schneider, Director of Content of the new series *Square One TV*, produced by the Children's Television Workshop. This exciting new series will premiere on public television on January 26 and is targeted to children ages eight to fourteen. Highlights include "Mathnet" (a take-off on *Dragnet*), which uses a detective metaphor to teach problem-solving, and a musical approach to infinity. Children from the local San Antonio school system will be invited to view this program

along with mathematicians and press. A question and answer session will follow the showing of the program.

AMS-MAA Panel Discussion

The AMS and MAA are cosponsoring a panel discussion at 7:00 p.m. on Thursday, January 22 on *What makes news in mathematics?* Speakers will include media representatives from the west coast, east coast, and the San Antonio area, and two mathematicians currently involved in public information in mathematics. A question and answer session will follow.

Activities of Other Organizations

The **Association for Symbolic Logic** (ASL) Council will meet on Thursday and Friday, January 22–23, from 8:00 p.m. to 11:00 p.m. Sessions will be on Friday and Saturday, January 23–24. There will be an ASL reception on Friday, January 23, from 5:30 p.m. to 7:00 p.m.

The **Association for Women in Mathematics** (AWM) will sponsor the seventh annual Emmy Noether Lecture at 1:00 p.m. on Friday, January 23, by Joan Birman. The title of her talk will be announced later.

The AWM will also sponsor a panel discussion on *Responses to the David Report: Initiatives for women and minorities* on Friday, January 23 at 9:00 a.m.

The AWM Business Meeting will be held at 10:00 a.m. on Friday, January 23.

A reception is being planned by AWM at 6:00 p.m. on Friday, January 23.

The **Interagency Commission for Extramural Mathematics Programs** (ICEMAP) will present a session at 4:25 p.m. on Wednesday, January 21. The program will focus on current topics in federal mathematical support. Presentations will be made by the National Science Foundation, Department of Energy, and the Department of Defense agencies discussing a variety of new and continuing programs and opportunities for federal funding.

The **Joint Policy Board for Mathematics** (JPBM) Committee for Mathematics Department Heads has organized a National Meeting of Department Heads at 7:00 p.m. on Thursday, January 22. This session will feature a program conducted by David P. Roselle, Provost at Virginia Polytechnic Institute and State University, on *Accreditation for mathematics departments*. This will be followed by Birds-of-a-Feather sessions on *The evaluation of instruction for large schools* by Donald W. Bushaw; *The evaluation of instruction for small schools* by David W. Ballew; *Master's degrees in the mathematical sciences for large schools* by Richard Haberman; and *Master's degrees in the mathematical sciences for small schools* by Benjamin A. Fusaro.

The Committee for Department Chairs of the JPBM will also cosponsor a workshop for department chairs with the American Council on Education (ACE) on Tuesday, January 20 from 9:00 a.m. to 5:00 p.m. Participants who are interested in this workshop should see **News and Announcements** in the October issue of the *Notices*.

The **National Association of Mathematicians** (NAM) will receive the William W. S. Claytor Lecture at 1:00 p.m. on Saturday, January 24. The name of the speaker and the title of this address will be announced later.

The NAM Business Meeting will take place at 10:00 a.m. on Saturday, January 24.

NAM will also sponsor a panel discussion on Saturday, January 24 at 9:00 a.m.

The **National Science Foundation** (NSF) will sponsor a session on *Federal support for mathematics education* at 5:30 p.m. on Wednesday, January 21, organized by John A. Thorpe, Deputy Division Director, Division of Materials Development, Research and Informal Science Education, National Science Foundation.

The NSF will also be represented at a booth in the exhibit area. NSF staff members will be available to provide counsel and information on NSF programs of interest to mathematicians. The booth will be open the same days and hours as the exhibits.

The **Rocky Mountain Mathematics Consortium** (RMMC) Board of Directors will meet on Thursday, January 22 from 2:15 p.m. to 4:15 p.m.

Other Events of Interest

Book Sales

Books published by the AMS and MAA will be sold at discounted prices somewhat below the cost for the same books purchased by mail. **These discounts will be available only to registered participants wearing the official meeting badge.** VISA and MASTERCARD credit cards will be accepted for book sale purchases at the meeting. The book sales will be open the same days and hours as the exhibits and are located in the North Banquet Hall.

Exhibits

The book and educational media exhibits will be located in the North Banquet Hall and will be open Wednesday through Friday, January 21–23 from 9:00 a.m. to 5:00 p.m. All participants are encouraged to visit the exhibits during the meeting. **Participants visiting the exhibits will be asked to display their meeting badge or acknowledgment of preregistration from the Mathematics Meetings Housing Bureau in order to enter the exhibit area.**

Mathematical Sciences Employment Register

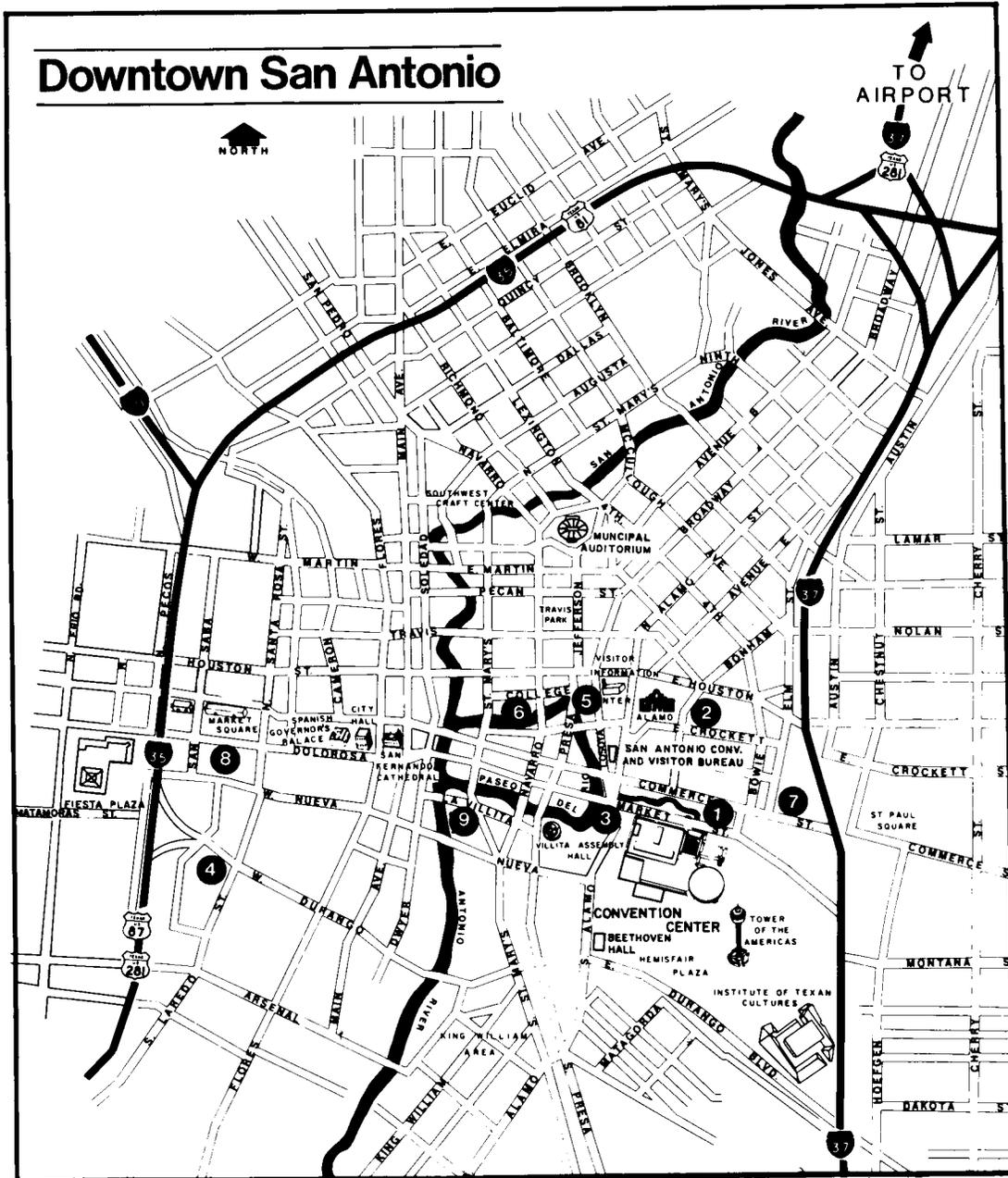
Those wishing to participate in the Employment Register at the San Antonio meetings should read carefully the important article about the Register which follows this meeting announcement.

Accommodations

Hotels

The rates listed below are subject to an 11 percent hotel/motel tax. The number in parentheses after the name of the hotel is the number it carries on the map. The estimated walking distance from the hotel to the San Antonio Convention Center is given in parentheses following the telephone number.

Participants should be aware that, when major conventions occur in any large city, additional safety problems are created, especially at night. Those who are attending the meetings alone, or who are concerned about walking to and from the meetings after dark, are



SAN ANTONIO MAP

HOTEL

1. San Antonio Marriott—Headquarters Hotel
2. The Crockett Hotel
3. Hilton Palacio del Rio Hotel
4. Holiday Inn—Downtown at Market Square
5. Hyatt Regency San Antonio Hotel
6. La Mansion del Rio Hotel
7. La Quinta Convention Center Motor Inn
8. La Quinta Market Square Motor Inn
9. Travelodge on the River

encouraged to choose a hotel in close proximity to the San Antonio Convention Center. Participants are also urged to read the "Words to the Wise" in the local information insert in the program they receive at the meetings.

Reservations at these hotels cannot be made by calling the hotel directly until after January 12. Also, after that date, the rates below may not apply.

In all cases "single" refers to one person in one bed; "double" refers to two persons in one bed; "twin" refers to two persons in two twin beds; and "twin double" refers to two persons in two double beds. A rollaway cot for an extra person can be added to a room; however, not all hotels are able to do so.

Participants should be aware that it is general hotel practice in most cities to hold a nonguaranteed reservation until 6:00 p.m. only. When one guarantees a reservation by paying a deposit or submitting a credit card number as guarantee in advance, however, the hotel usually will honor this reservation up until checkout time the following day. If the individual holding the reservation has not checked in by that time, the room is then released for sale, and the hotel retains the deposit or applies one night's room charge to the credit card number submitted.

If you hold a guaranteed reservation at a hotel, but are informed upon arrival that there is no room for you, there are certain things you can request the hotel do. First, they should provide for a room at another hotel in town for that evening, at no charge. (You have already paid for the first night when you made your deposit.) They should pay for taxi fares to the other hotel that evening, and back to the meetings the following morning. They should also pay for one telephone toll call so that you can let people know you are not at the hotel you expected. They should make every effort to find a room for you in their hotel the following day, and, if successful, pay your taxi fares to and from the second hotel so that you can pick up your baggage and bring it to the first hotel. Not all hotels in all cities follow this practice, so your request for these services may bring mixed results, or none at all.

Please make all changes to or cancellations of hotel reservations with the Mathematics Meetings Housing Bureau in Providence **before January 12, 1987**. The telephone number in Providence is 401-272-9500 (extension 239). After that date, changes should be made directly with the hotel. **Cancellations must be made directly with the hotel 48 hours prior to date of arrival in order to receive refunds of deposits.**

The following hotels/motels accept American Express, MASTERCARD, VISA, Carte Blanche, Diners Club credit cards, personal checks with identification, and travelers' checks in payment for room charges.

Please note that public transportation is limited on Saturdays in San Antonio. Participants who have been assigned to the Holiday Inn Downtown - Market Square and the La Quinta Market Square Motor Inn should be prepared to use taxicabs to and from the San Antonio Convention Center on that day.

San Antonio Marriott (1)

Headquarters Hotel

711 E. Riverwalk

San Antonio, Texas 78205

Telephone: 512-224-4555 (1 block)

Singles	\$60
Doubles	\$60
Triples	\$66
Triples	\$66 (with cot)
Quads	\$70
Quads	\$70 (with cot)
Suites	\$125 - \$300

There is no charge for children 12 years of age and under. The San Antonio Marriott is a full-service hotel.

The Crockett Hotel (2)

320 Bonham

San Antonio, Texas 78205-2083

Telephone: 512-225-6500 (3 blocks)

Singles	\$54
Doubles	\$54
Triples	\$59
Quads	\$59
Suites	\$150

There is no charge for children 18 years of age and under. The Crockett Hotel is a full-service hotel.

Hilton Palacio del Rio (3)

200 South Alamo

San Antonio, Texas 78205

Telephone: 512-222-1400 (1 block)

Singles	\$60
Doubles	\$60
Triples	\$66
Triples	\$66 (with cot)
Quads	\$70

There is no charge for children. The Hilton is a full-service hotel.

Holiday Inn Downtown at Market Square (4)

318 West Durango

San Antonio, Texas 78204

Telephone: 512-225-3211 (10 blocks)

Singles	\$47
Doubles	\$47
Triples	\$47
Triples	\$47 (with cot)
Quads	\$47
Quads	\$47 (with cot)

There is no charge for children 17 years of age and under. The Holiday Inn is a full-service hotel.

Hyatt Regency San Antonio (5)

123 Losoya Street

San Antonio, Texas 78205

Telephone: 512-222-1234 (3 blocks)

Singles	\$62
Doubles	\$68
Triples	\$75
Triples	\$90 (with cot)
Quads	\$75
Quads	\$90 (with cot)
Suites	\$150 - \$411

There is no charge for children 18 years of age and under. The Hyatt Regency is a full-service hotel.

La Mansion del Rio Hotel (6)

112 College Street

San Antonio, Texas 78205

Telephone: 512-225-2581 (4 blocks)

Singles	\$60
Doubles	\$70
Triples	\$80
Triples	\$80 (with cot)
Quads	\$80
Quads	\$80 (with cot)
Suites	\$275 - \$425

There is no charge for children 18 years of age and under. The La Mansion is a full-service hotel.

La Quinta Convention Center Motor Inn (7)

1001 E. Commerce Street
San Antonio, Texas 78205
Telephone: 512-222-9181 (2 blocks)

Singles	\$46
Doubles	\$56
Triples	\$61
Triples	\$61 (with cot)
Quads	\$66
Quads	\$66 (with cot)

There is no charge for children 18 years of age and under. The La Quinta Convention Center Motor Inn is a full-service Inn.

La Quinta Market Square Motor Inn (8)

900 Dolorosa Street
San Antonio, Texas 78207
Telephone: 512-271-0001 (10 blocks)

Singles	\$37
Doubles	\$45
Triples	\$49
Quads	\$49

There is no charge for children 17 years of age and under. There are no food services available in this Inn.

Travelodge on the River (9)

100 Villita Street
San Antonio, Texas 78205
Telephone: 512-226-2271 (4 blocks)

Singles	\$43
Doubles	\$46
Triples	\$49
Triples	\$49 (with cot)
Quads	\$52
Quads	\$52 (with cot)
Suites	\$90

There is no charge for children 17 years of age and under. The Travelodge is a full-service hotel, and provides free transportation to and from the airport baggage claim areas.

The AMS-MAA Joint Meetings Committee always endeavors to obtain the lowest possible sleeping room rates for participants at annual meetings. The Committee is also responsible for maintaining a sound fiscal position for these meetings, and, until recently, has been able to keep the deficits at a reasonable level, while still providing the very best meeting facilities available to the participants.

As the meetings have grown in scope and complexity over the years, however, it has been necessary to find larger facilities with more and more session rooms. Unfortunately, the cost of these facilities is higher than can be covered by the registration fees, and the Committee has arranged for all of the hotels in San Antonio to collect

an extra \$2 per room per night from participants, which will be used to offset the rental cost of the San Antonio Convention Center. (The rates above include this extra charge.) The Committee hopes that these extra funds will not be necessary at future annual meetings, and therefore chose this method over an increase in the registration fees.

Registration at the Meetings

Meeting preregistration and registration fees only partially cover expenses of holding meetings. All mathematicians who wish to attend sessions are expected to register, and should be prepared to show their meeting badge, if so requested. **Badges are required to enter the exhibit area, to obtain discounts at the AMS and MAA Book Sales, to cash a check with the meeting cashier, and to attend all sessions scheduled in the Theatre in the San Antonio Convention Center. (If a preregistrant should arrive too late in the day to pick up his/her badge, he/she may show the acknowledgment of preregistration received from the Mathematics Meetings Housing Bureau as proof of registration.)** The fees for Joint Meetings registration at the meeting listed below are 30 percent more than the preregistration fees.

Participants wishing to attend sessions for one day only may take advantage of the one-day fees listed below. These special fees are effective daily January 21 through 24, and are available at the meeting to members and nonmembers only. These one-day fees are not applicable to student, unemployed, or emeritus participants, whose fees for registration at the meetings are listed below.

Joint Mathematics Meetings

Member of AMS, ASL, MAA or NCTM	\$ 77
Emeritus Member of AMS, MAA	\$ 21
Nonmember	\$117
Student/Unemployed	\$ 21

One Day Fee

Member of AMS, ASL, MAA or NCTM	\$ 40
Nonmember	\$ 61

Employment Register

Employer	\$100
Applicant	\$ 20
Employer Posting fee	\$ 15

AMS Short Course

Student/Unemployed	\$ 15
All Other Participants	\$ 45

MAA Minicourses

(if openings available)

Minicourses # 1, 2, 5, 6, 8, 9, or 12	\$ 35
Minicourses # 3, 4, 10, 11, 13, 14, or 15	\$ 25

Registration fees may be paid at the meetings in cash, by personal or travelers' check, or by VISA or MASTERCARD credit card. Canadian checks must be marked for payment in U.S. funds.

There is no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

All **full-time** students currently working toward a degree or diploma qualify for the student registration fees, regardless of income.

The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include any person who has voluntarily resigned or retired from his or her latest position.

Persons who qualify for emeritus membership in either the Society or the Association may register at the emeritus member rate. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more, and is retired on account of age from his or her latest position.

Nonmembers who preregister or register at the meeting and pay the nonmember fee will receive mailings from AMS and MAA, after the meeting is over, containing information about a special membership offer.

Registration Dates, Times, and Locations

AMS Short Course

Outside Room 102, San Antonio Convention Center
Tuesday, January 20 10:00 a.m. to 3:00 p.m.

Joint Mathematics Meetings

[and MAA Minicourses (until filled)]

North Banquet Hall, San Antonio Convention Center
Tuesday, January 20 4:00 p.m. to 8:00 p.m.
Wednesday, January 21 8:00 a.m. to 5:00 p.m.
Thursday, January 22
through 8:00 a.m. to 4:00 p.m.
Saturday, January 24

Registration Desk Services

Assistance, Comments, and Complaints

A log for registering participants' comments or complaints about the meeting is kept at the Transparencies section of the registration desk. All participants are encouraged to use this method of helping to improve future meetings. Comments on all phases of the meeting are welcome. If a written reply is desired, participants should furnish their name and address.

Participants with problems of an immediate nature requiring action at the meeting should see the Director of Meetings, who will try to assist them.

Audio-Visual Assistance

A member of the AMS/MAA staff will be available to advise or consult with speakers on audio-visual usage. Speakers having unusual audio-visual requirements such as slide or film projectors should make their requests **prior to the beginning of the meeting.**

Rooms where special sessions and contributed paper sessions will be held are equipped with an overhead projector and screen. **Blackboards will not be available.**

Baggage and Coat Check

Inquire at the meetings registration desk.

Information Table

The information table at Joint Meetings of the AMS and MAA is set up in the registration area for the dissemination of information of a nonmathematical nature of possible interest to the members. The administration of the information table is in the hands of the AMS-MAA Joint Meetings Committee, as are all arrangements for such joint meetings. The following rules and procedures apply.

1. Announcements submitted by participants should ordinarily be limited to a single sheet no more than $8\frac{1}{2}'' \times 14''$.

2. A copy of any announcement proposed for the table is to be sent to: H. Hope Daly, American Mathematical Society, Post Office Box 6248, Providence, Rhode Island 02940 to arrive at least one week before the first day of the scientific sessions.

3. The judgment on the suitability of an announcement for display rests with the Joint Meetings Committee. It will make its judgments on a case by case basis to establish precedents.

4. Announcements of events competing in time or place with the scheduled scientific program will not be accepted.

5. Copies of an accepted announcement for the table are to be provided by the proponent. Announcements are not to be distributed in any other way at the meeting (for example, not by posting or personal distribution of handbills).

6. It may be necessary to limit the number of events or the quantity of announcements distributed at a meeting.

7. At the close of registration, the table will be swept clean. A proponent who wishes the return of extra copies should remove them.

Check Cashing

The meeting cashier will cash personal or travelers' checks up to \$50, upon presentation of the official meeting registration badge, provided there is enough cash on hand. Canadian checks must be marked for payment in U.S. funds. It is advisable that participants bring travelers' checks with them. When funds are low the meetings cashier will not be able to cash checks and travelers' checks can be easily cashed at local banks, restaurants, or hotels.

Local Information

This section of the desk will be staffed by members of the Local Arrangements Committee and other volunteers from the San Antonio mathematical community.

Lost and Found

See the Joint Meetings cashier.

Mail

All mail and telegrams for persons attending the meetings should be addressed as follows: Name of Participant, c/o Joint Mathematics Meetings, P. O. Box 2277, San Antonio, TX 78298. Mail and telegrams so addressed may be picked up at the mailbox in the registration area

during the hours the registration desk is open. U.S. mail not picked up will be forwarded after the meeting to the mailing address given on the participant's registration record.

Personal Messages

Participants wishing to exchange messages during the meeting should use the mailbox mentioned above. Message pads and pencils are provided. It is regretted that such messages left in the box cannot be forwarded to participants after the meeting is over.

Telephone Messages

A telephone message center is located in the registration area to receive incoming calls for participants. The center is open from January 20 through 24, during the hours that the Joint Mathematics Meetings registration desk is open. Messages will be taken and the name of any individual for whom a message has been received will be posted until the message has been picked up at the message center. The telephone number of the message center will be announced later.

Transparencies

Speakers wishing to prepare transparencies in advance of their talk will find the necessary materials and copying machines at this section of the registration desk. A member of the staff will assist and advise speakers on the best procedures and methods for preparation of their material. There is a modest charge for these materials.

Visual Index

An alphabetical list of registered participants, including local addresses and arrival and departure dates, is maintained in the registration area.

Miscellaneous Information

Child Care

The Marriott Hotel has babysitting services available which can be arranged through the Concierge desk or by calling North Side Sitters at 341-9313. The current rates are \$4 per hour for one family and \$5.50 per hour for more than one family in the same room. There is a four-hour minimum and an additional \$7 transportation and parking fee for the babysitter. A list of local babysitters is available at the Local Information section of the registration desk.

Local Information

The Paseo del Rio, an arm of the San Antonio River, extends for about two-and-one-half miles through the center of the city. Located on the river are several of the major hotels, as well as restaurants, shops, craftsmen, and art galleries. Small river taxis ply the river, and one may go from one end of the river to the other for a nominal fee. The banks of the river are beautifully landscaped, and a walkway known as the "River Walk" extends the length of the river with frequent egresses to hotels and shops away from the river. The Convention Center is at one end of the Paseo del Rio.

Among the many places of interest in San Antonio are the Alamo (including the Alamo Museum); Brackenridge Park, which has a Chinese Sunken Garden, a one-fifth scale model of a diesel train, and the San Antonio Zoo, ranked as one of the finest in the world; the Hertzberg Circus Collection; La Villita and the Arneson River Theater, a small historic Mexican village and an open air theater; the five Missions of San Antonio, founded between 1720 and 1731; and the Spanish Governor's Palace.

Parking

Parking is available at all hotels as follows:

San Antonio Marriott - Valet parking is \$5 per night; self-parking in adjacent lot is approximately \$2.25.

The Crockett Hotel - Valet parking is \$6 per night.

Hilton Palacio del Rio - Valet parking is \$7.50 per night.

Holiday Inn Downtown at Market Square - There is no charge for parking.

Hyatt Regency San Antonio - Valet parking is \$7 per night.

La Mansion del Rio Hotel - Valet parking is \$6 per night.

La Quinta Convention Center Motor Inn - There is no charge for parking.

La Quinta Market Square Motor Inn - There is no charge for parking.

Travelodge on the River - There is no charge for parking.

Although most hotels offer valet parking, there are also self-parking lots in the area. Further information on parking will be available later.

Smoking

Please note that smoking is not allowed in any of the session rooms in the San Antonio Convention Center or the San Antonio Marriott Hotel.

Social Event

There will be a no-host cocktail party in the Arcade in the San Antonio Convention Center at 8:00 p.m. on Thursday, January 22.

Travel

In January, San Antonio is on Central Standard Time. There is regular airline service to the San Antonio International Airport by several major airline carriers. The airport is a little over eight miles from the city center, which takes about ten minutes to reach by taxi (\$10) or by airport limousine (\$5). Most major car rental agencies maintain desks at the airport. Amtrak has thrice-weekly service from New Orleans to the east, and from Los Angeles to the west, and from St. Louis to the northeast.

Weather

The location of San Antonio on the edge of the Gulf Coastal Plains results in a modified subtropical climate, predominantly continental during the winter months. The average daily high temperature for January is 62 degrees F, and the daily low 42 degrees F.

MAA PROGRAM

Tuesday, January 20

- 9:00 a.m. – 4:00 p.m. **Board of Governors' Meeting**
 7:00 p.m. – 9:00 p.m. **Section Officers' Meeting**

Wednesday, January 21

- morning– **Contributed Paper Session:** *New methods of teaching calculus*, Wade Ellis, Jr., West Valley College, San Jose
 morning– **Contributed Paper Session:** *Experiences with computer support for service courses*, Carol Jones, University of Houston-Downtown
 8:30 a.m. – 11:00 a.m. **Session:** *The leading edge of software*, Warren Page, New York City Technical College (CUNY)
 9:00 a.m. – 10:55 a.m. **Minicourse #1 (Part A):** *A microcomputer linear algebra course using LIN-KIT*, Howard Anton
 9:00 a.m. – 10:55 a.m. **Minicourse #2 (Part A):** *Introduction to computer graphics*, Joan P. Wyzkoski, Fairfield University
 9:00 a.m. – 10:55 a.m. **Minicourse #3 (Part A):** *The teaching of applied mathematics*, W. Gilbert Strang, Massachusetts Institute of Technology
 9:00 a.m. – 10:55 a.m. **MAA-NCTM Panel Discussion:** *Reform in mathematics education*, John Dossey, president of NCTM
 2:15 p.m. – 3:05 p.m. **Invited Address:** *Algebraic topology and robots*, Daniel H. Gottlieb, Purdue University
 3:20 p.m. – 4:10 p.m. **Invited Address:** *Artificial worlds and real mathematics*, Andy deSessa, University of California, Berkeley
 4:30 p.m. – 6:00 p.m. **Informal Reception:** Committee on Two-Year Colleges Cash Bar Social Hour and Discussion
 4:30 p.m. – 6:30 p.m. **Minicourse #5 (Part A):** *Discrete mathematics using difference equations*, James T. Sandefur, Jr., Georgetown University
 4:30 p.m. – 6:30 p.m. **Minicourse #6 (Part A):** *Using microcomputer software in teaching calculus*, David P. Kraines, Duke University and David A. Smith, Benedict College

Thursday, January 22

- 9:00 a.m. – 9:50 a.m. **Invited Address:** *Networks, parallel computation, and VLSI*, Frank T. Leighton, Massachusetts Institute of Technology
 10:05 a.m. – 10:55 a.m. **Invited Address:** *Self-similarity and hairiness in the Mandelbrot set*, John W. Milnor, Institute for Advanced Study
 11:10 a.m. – noon **AMS-MAA Invited Address:** *Algebraic traditions on two continents*, Uta C. Merzbach, National Museum of American History
 afternoon– **Contributed Paper Session:** *The history of mathematics*, Duane Blumberg, University of Southwestern Louisiana
 2:15 p.m. – 3:45 p.m. **Panel Discussion:** *Post-secondary mathematics at ICME-6: What are the major issues?*, John M. Mack, University of Sydney, and Lynn A. Steen, St. Olaf College
 2:15 p.m. – 4:15 p.m. **Minicourse #1 (Part B):** *A microcomputer linear algebra course using LIN-KIT*, Howard Anton
 2:15 p.m. – 4:15 p.m. **Minicourse #2 (Part B):** *Introduction to computer graphics*, Joan P. Wyzkoski, Fairfield University
 2:15 p.m. – 4:15 p.m. **Minicourse #3 (Part B):** *The teaching of applied mathematics*, W. Gilbert Strang, Massachusetts Institute of Technology
 2:15 p.m. – 4:15 p.m. **Presentation:** *The mathematical competition in modeling (MCM)*, Benjamin A. Fusaro, Salisbury State College
 2:15 p.m. – 4:00 p.m. **Panel Discussion:** Zaven A. Karian, Joint MAA-ACM-IEEE Task Force on Teaching Computer Science in Mathematics Departments
 7:00 p.m. – 9:00 p.m. **Minicourse #5 (Part B):** *Discrete mathematics using difference equations*, James T. Sandefur, Jr., Georgetown University
 7:00 p.m. – 9:00 p.m. **Minicourse #6 (Part B):** *Using microcomputer software in teaching calculus*, David P. Kraines, Duke University and David A. Smith, Benedict College
 7:00 p.m. – 9:30 p.m. **AMS-MAA Symposium:** *The role of mathematicians in pre-college education*, Philip Wagreich, University of Illinois at Chicago
 7:00 p.m. – 9:30 p.m. **AMS-MAA Panel Discussion:** *What makes news in mathematics?*

Friday, January 23

- morning*— **Contributed Paper Session:** *Remedial mathematics: Issues and innovations*, Geoffrey R. Akst, Borough Manhattan Community College (CUNY)
- 8:00 a.m. – 10:55 a.m. **Session:** *Mathematics as a humanistic discipline*, Alvin White, Harvey Mudd College
- 9:00 a.m. – 10:30 a.m. **Panel Discussion:** *The use of computers in teaching differential equations*, Howard Lewis Penn, Committee on Computers in Mathematics Education (CCIME)
- 9:00 a.m. – 10:55 a.m. **Minicourse #4 (Part A):** *Interesting applications of elementary mathematics*, JoAnne S. Growney, Bloomsburg University
- 9:00 a.m. – 10:55 a.m. **Minicourse #8 (Part A):** *Computer simulation of discrete systems*, Zaven A. Karian, Denison University
- 9:00 a.m. – 10:55 a.m. **Minicourse #9 (Part A):** *Recurrence relations*, Margaret Barry Cozzens, Northeastern University
- 9:00 a.m. – 10:55 a.m. **Minicourse #10 (Part A):** *Integrating history into undergraduate mathematics courses*, Judith V. Grabiner, Pitzer College
- 9:00 a.m. – 10:55 a.m. **Minicourse #11 (Part A):** *Teaching mathematical modeling*, Frank R. Giordano, U.S. Military Academy and Maurice D. Weir, Naval Postgraduate School
- 9:30 a.m. – 10:55 a.m. **AMS-MAA-Mathematical Sciences Education Board Forum:** *The K-12 Curriculum*
- 11:10 a.m. – noon **AMS-MAA Invited Address:** *Strange attractors: Are they still strange?*, Edward N. Lorenz, Massachusetts Institute of Technology
- 2:15 p.m. – 3:05 p.m. **Invited Address:** *Game theory, nuclear deterrence, and Star Wars*, Steven J. Brams, New York University
- 3:20 p.m. – 5:40 p.m. **Prize Session and Business Meeting:** Chauvenet Prize, Award for Distinguished Service to Mathematics, Certificates of Meritorious Service; Allendoerfer, Ford and Pólya Awards
- 7:00 p.m. – 9:00 p.m. **Minicourse #4 (Part B):** *Interesting applications of elementary mathematics*, JoAnne S. Growney, Bloomsburg University
- 7:00 p.m. – 9:00 p.m. **Minicourse #12 (Part A):** *True BASIC in freshman calculus*, James F. Hurley, University of Connecticut
- 7:00 p.m. – 9:00 p.m. **Minicourse #13 (Part A):** *For all practical purposes*, Solomon A. Garfunkel, COMAP, Inc.
- 7:00 p.m. – 9:00 p.m. **Minicourse #14 (Part A):** *Applications of discrete mathematics*, Fred Stephen Roberts, Rutgers University
- 7:00 p.m. – 9:00 p.m. **Minicourse #15 (Part A):** *Constructing placement examinations*, John W. Kenelly, Clemson University
- 7:30 p.m. – 10:00 p.m. **Films:** *Planar double pendulum* and *Fly Lorenz*

Saturday, January 24

- 9:00 a.m. – 9:50 a.m. **Invited Address:** *Euclidean/non-Euclidean wave equation*, Peter D. Lax, Courant Institute for Mathematical Sciences, New York University
- 10:05 a.m. – 10:55 a.m. **Invited Address:** *The strong law of small numbers*, Richard K. Guy, University of Calgary
- afternoon*— **Contributed Paper Session:** *Retaining and recruiting undergraduate women in mathematics courses: Aspirations and experiences*, Patricia C. Kenschaft, Montclair State College
- 1:00 p.m. – 3:00 p.m. **Minicourse #8 (Part B):** *Computer simulation of discrete systems*, Zaven A. Karian, Denison University
- 1:00 p.m. – 3:00 p.m. **Minicourse #9 (Part B):** *Recurrence relations*, Margaret Barry Cozzens, Northeastern University
- 1:00 p.m. – 3:00 p.m. **Minicourse #10 (Part B):** *Integrating history into undergraduate mathematics courses*, Judith V. Grabiner, Pitzer College
- 1:00 p.m. – 3:00 p.m. **Minicourse #11 (Part B):** *Teaching mathematical modeling*, Frank R. Giordano, U.S. Military Academy and Maurice D. Weir, Naval Postgraduate School
- 2:15 p.m. – 4:15 p.m. **Panel Discussion:** *Mathematics Panel Report of AAAS Project 2061*, Leon Henkin, University of California
- 2:15 p.m. – 4:15 p.m. **Presentation:** *Working with statistics: Statistical process control (SPC) techniques*, Barbara Ashley and Analisa L. France, Jefferson Community College (Louisville, KY)
- 3:30 p.m. – 5:30 p.m. **Minicourse #11 (Part C-Optional):** *Teaching mathematical modeling*, Frank R. Giordano, U.S. Military Academy and Maurice D. Weir, Naval Postgraduate School
- 3:30 p.m. – 5:30 p.m. **Minicourse #12 (Part B):** *True BASIC in freshman calculus*, James F. Hurley, University of Connecticut
- 3:30 p.m. – 5:30 p.m. **Minicourse #13 (Part B):** *For all practical purposes*, Solomon A. Garfunkel, COMAP, Inc.
- 3:30 p.m. – 5:30 p.m. **Minicourse #14 (Part B):** *Applications of discrete mathematics*, Fred Stephen Roberts, Rutgers University
- 3:30 p.m. – 5:30 p.m. **Minicourse #15 (Part B):** *Constructing placement examinations*, John W. Kenelly, Clemson University

AMS-MAA Joint Program Committee: Judith V. Grabiner (chairman), Paul R. Halmos, F. Reese Harvey, and W. Gilbert Strang

Local Arrangements Committee: Donald F. Bailey, Robert M. Fossum (ex-officio), William J. LeVeque (ex-officio), Kenneth A. Ross (ex-officio), Gregory P. Wene (chairman), Lawrence R. Williams, and Bennir A. Zinn.

Housing

Special Bonus for Early Preregistrants!

Participants who preregister before the *early* preregistration deadline of **October 31** will be eligible for a complimentary room in San Antonio. (Multiple occupancy of these rooms is permissible.) Winners will be randomly selected from the names of all who preregister by October 31 and these lucky individuals will be notified by mail by January 16. **So, preregister early!**

Acknowledgment Form

Participants will receive an acknowledgement of their preregistration, room deposit, and hotel assignment from the Mathematics Meetings Housing Bureau, which will be followed by a confirmation of the room reservation from the hotel to which they have been assigned.

The Preregistration/Housing Form for requesting hotel accommodations will be found at the back of this issue. Use of the services offered by the Mathematics Meetings Housing Bureau requires preregistration for the meetings. Persons desiring confirmed hotel accommodations should complete the form, or a reasonable facsimile, and send it to the Mathematics Meetings Housing Bureau, Post Office Box 6887, Providence, Rhode Island 02940, **so that it will arrive no later than November 15, 1986. Housing requests received after the deadline of November 15 most surely cannot be honored.**

All reservation requests must be received in writing and will be processed through the Housing Bureau in Providence. Telephone requests will not be accepted. **Please do not contact the hotels directly.** Blocks of rooms and special rates have been set aside for the Housing Bureau, and the hotel will either refer you back to the Housing Bureau, or give you a room outside of the block, which may be at a higher rate. Please note that the room occupancy tax in San Antonio is 11 percent.

Please read carefully the section on **Hotels** before completing the form. Forms sent to the wrong address and thus incurring delay in delivery to the Housing Bureau until after the deadline cannot be accepted and will, therefore, be returned.

Participants requesting hotel accommodations in San Antonio are required to submit housing deposits or credit card information when preregistering. Deposits may be paid by check payable to the AMS (Canadian checks must be marked for payment in U.S. funds), or by providing a VISA or MASTERCARD credit card number on the Preregistration/Housing Form. Please be sure to give the name and number **exactly** as they appear on the credit card, and to include the expiration date. Please note that when you provide a credit card number in lieu of a \$50 check as a guarantee, no charge against your account will be processed by the hotel **unless you fail to claim the reserved room on your given arrival date, or if you fail to cancel your reservation directly with the hotel/motel 48 hours in advance of your given arrival date.** If

either of the latter two circumstances apply, the hotel will then charge your credit card account for one night's occupancy. **Please read the section on Hotels carefully regarding deposits.**

Housing assignments are made on a first-come, first-served basis, so participants desiring low-cost accommodations are urged to submit their housing requests in as early as possible. Participants should also be aware that the special rates being offered in the section titled **Hotels** may not be available after **December 31.**

Participants are strongly urged to rank each hotel on the housing form in the order of preference, and circle the type of room and the rate desired. Reservations will be made in accordance with preferences indicated on the reservation form insofar as this is possible. 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 lowest rate.

Participants who are able to do so are urged to share a room whenever possible as this procedure can be economically beneficial. The housing form should be fully completed to ensure proper assignment of rooms. Participants planning to share accommodations should provide the name(s) of the person(s) with whom they plan to occupy a room. Each participant should, however, complete a separate Preregistration/Housing Form. **In order to avoid confusion, parties planning to share rooms should send their forms together in the same envelope. The participant requesting the room should submit the deposit and will be the recipient of the hotel confirmation.**

Please make all changes to or cancellations of hotel reservations with the Housing Bureau in Providence **before January 12, 1986, by calling 401-272-9500, extension 239.** After that date, changes or cancellations should be made directly with the hotel assigned.

Please read the facing page titled **Preregistration** carefully before completing the Preregistration/Housing Form.

Please be sure to send housing deposit or credit card information with Preregistration/Housing Form.

Preregistration

Preregistration for these meetings and the Mathematical Sciences Employment Register **must be completed by November 15, 1986**. Those wishing to preregister must complete the form which appears at the back of this issue and submit it together with the appropriate preregistration fee(s) to the Mathematics Meetings Housing Bureau in Providence by **November 15**. Please note that a space has been provided on the Preregistration/Housing Form if one wishes to have his/her nickname printed on the meeting badge.

Preregistration fees do not represent an advance deposit for lodgings. One must, however, preregister for the meetings in order to obtain hotel accommodations through the Mathematics Meetings Housing Bureau, as outlined on the facing page.

Preregistration fees may be paid by check payable to the American Mathematical Society (Canadian checks must be marked for payment in U.S. funds), or by providing a VISA or MASTERCARD credit card number on the Preregistration/Housing Form. **Please be sure to give the name and number exactly as they appear on the credit card, and to include the expiration date.**

Those who preregister for the Joint Mathematics Meetings pay fees which are 30 percent lower than those who register at the meetings. The preregistration fees are as follows:

AMS Short Course

Student/Unemployed	\$10
All Others	\$35

Joint Mathematics Meetings

Member of AMS, ASL, MAA, NCTM	\$59
Emeritus Member of AMS, MAA	\$16
Nonmember	\$90
Student/Unemployed	\$16

Employment Register

Employer	\$75
Applicant	\$15
Employer posting fee	\$10

There will be no extra charge for members of the families of registered participants, except that all professional mathematicians who wish to attend sessions must register independently.

All **full-time** students currently working toward a degree or diploma qualify for the student registration fees, regardless of income.

The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is

not intended to include any person who has voluntarily resigned or retired from his or her latest position.

The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more, and is retired on account of age from his or her latest position.

A \$5 charge will be imposed for all invoices prepared when Preregistration/Housing Forms are submitted without accompanying payment for the preregistration fee(s) and room deposits, or are accompanied by an amount insufficient to cover the total due. Preregistration/Housing Forms received well before the deadline of **November 15** which are not accompanied by correct payment will be returned to the participant with a request for resubmission and full payment. **This will, of course, delay the processing of any housing request so that it will be unlikely that the participant's first choices will still be available.**

A 50 percent refund of the preregistration fee(s) will be made for all cancellations received in Providence no later than January 16. **No refunds will be granted for cancellations received after that date**, or to persons who do not attend the meetings.

The only exception to this rule is someone who preregisters for the Joint Mathematics Meetings only in order to attend an MAA Minicourse, and is too late to obtain a slot in the Minicourse. In this case, full refund will be made of the Joint Mathematics Meetings preregistration fee, **provided the preregistrant has checked the box** on the MAA Minicourse Preregistration Form that this was his or her intent. Individuals who preregister for both the Joint Meetings and a Minicourse and who intend to participate in the Joint Meetings, even if the Minicourse is not available, should **not**, of course, check the box on the MAA Minicourse Preregistration Form. In this case the Joint Meetings preregistration will be processed.

Those who wish to preregister for the Employment Register should read carefully the special article titled "Mathematical Sciences Employment Register" which follows this announcement of the San Antonio meetings. The attention of applicants is particularly directed to the section regarding the December issue of *Employment Information in the Mathematical Sciences*.

Please read the facing page titled **Housing** carefully before completing the Preregistration/Housing Form.

SPECIAL AIRFARES 1-800-826-6011

**RECEIVE A FREE
ARRIVAL TRANSFER**

**WIN A FREE
AIRLINE TICKET**

**SAVE 40% TO 60% ON YOUR AIRFARE TO THE JOINT MATHEMATICS MEETING
IN SAN ANTONIO, JANUARY 21-24, 1987.**

MICA, the official travel management firm for the San Antonio meetings, has arranged savings of 40% to 60% off regular American and Eastern Airlines coach fares and 30% off Eastern Airlines first class fare.*

Win a free roundtrip airline ticket good for travel within the U.S., including Hawaii! Simply make your airline reservations through the toll-free number and your name will be entered into a drawing to be held at the San Antonio meeting.

For additional savings...with all tickets purchased through the toll-free number you will receive a free transfer from the airport to the hotel.

Sample Airfares to San Antonio
(Quoted 6/24/86 and subject to change)

Originating City	Coach Fares	MICA Discounted Fares
Boston	\$814.00	\$489.00
Chicago	\$660.00	\$396.00
Los Angeles	\$500.00	\$300.00
New Orleans	\$198.00	\$118.00
New York	\$758.00	\$454.80
Philadelphia	\$740.00	\$444.00

You may qualify for even greater savings. The lowest fares require a Saturday night stay and may be subject to an airline change/cancellation penalty.

Make your reservations today! MICA reservationists can guarantee you receive the lowest available airfare on any airline. The earlier you call, the greater your savings!

You may pay by credit card or ask to be invoiced. We urge you to purchase your airline tickets without delay using your credit card. This will confirm your reservation, the current airfare and protect you against later fare increases.

Remember, these special discounts are available only through MICA's toll-free number.

*Canadian attendees can save 25% to 60% off regular coach fares, additional restrictions may apply.

Call Today - Toll-Free 1-800-826-6011 And Save

In Connecticut and outside the Continental U.S. call (203) 678-1040

Monday - Friday, 9:00 a.m. - 5:30 p.m. E.S.T.



PREREGISTRATION/HOUSING FORM, SAN ANTONIO, TEXAS
January 21-24, 1987

MUST BE RECEIVED IN PROVIDENCE NO LATER THAN NOVEMBER 15, 1986

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. 239

DEADLINES:

Preregistration: November 15, 1986.

Changes/Cancellations: Before January 12, 1987, make all changes to or cancellations of hotel reservations with the Mathematics Meetings Housing Bureau in Providence; after that date, changes or cancellations should be made directly with the hotel assigned.

Refunds: 50% of preregistration fee(s) for the AMS Short Course or the Joint Meetings will be refunded in Providence on or before January 16, 1987. After this date, there will be no refunds.

JOINT MATHEMATICS MEETINGS	REGISTRATION FEES	
	Preregistration by mail by 11/15	At Meeting
Member of AMS, ASL, MAA, NCTM	\$59	\$77
Nonmember	\$90	\$117
* Student, Unemployed, or Emeritus	\$16	\$21
AMS SHORT COURSE		
Member/Nonmember	\$35	\$45
* Student or Unemployed	\$10	\$15
EMPLOYMENT REGISTER - Employer fee	\$75	\$100
- Applicant fee	\$15	\$20
- Posting fee for job descriptions for noninterviewing employers	\$10	\$15

(N. B.: A separate form appears in this issue for preregistration for MAA Minicourses.)

* All full-time students currently working toward a degree or diploma qualify for the student registration fees, regardless of income. The unemployed status refers to any person currently unemployed, actively seeking employment, and who is not a student. It is not intended to include persons who have voluntarily resigned from their latest position. The emeritus status refers to any person who has been a member of the AMS or MAA for twenty years or more and is retired on account of age from his or her latest position.

PREREGISTRATION SECTION: Please check the function(s) for which you are preregistering:

Joint Meetings [] AMS Short Course [] Employer [] Applicant [] Posting []
(January 20-22)

1) _____ Nickname for badge _____
(Please print) Surname First Middle (optional)

2) _____
(Mailing address)

3) Employing institution _____ Emeritus member [] Unemployed []

4) I am a student at _____ (5) Accompanied by spouse _____; number of children _____

6) Member of AMS [] ASL [] MAA [] NCTM [] NONMEMBER [] (Member discount applies only to members of AMS, ASL, MAA and NCTM.) Member of other organizations: AWM [] NAM []

7) Joint Meetings fee \$ _____ (8) AMS Short Course fee \$ _____ (9) Employer fee \$ _____

10) Applicant fee \$ _____ (11) Posting fee \$ _____ (12) Hotel deposit enclosed \$ _____

13) TOTAL AMOUNT ENCLOSED FOR 7 through 12 \$ _____ NOTE: May be paid by check payable to AMS (Canadian checks must be marked "In U.S. Funds") or VISA or MasterCard credit cards.

Credit card type: _____; Card number: _____; Expiration date: _____

Telephone: _____ Signature (name as it appears on credit card)

[] PLEASE CHECK HERE IF YOU WILL NOT REQUIRE A ROOM.

Please be sure to complete the section on next page if you will require hotel accommodations.

For office use only:

Codes:	Options:	Hotel:	Room type:
Dates:	Amount paid:		
Special remarks:			

PREREGISTRATION and HOUSING FORMS

PREREGISTRATION/HOUSING FORM, SAN ANTONIO, TEXAS

HOUSING SECTION:

JANUARY 1987

Please rank hotels in order of preference by writing 1, 2, 3, in the spaces at 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 11% hotel/motel occupancy tax.

GUARANTEE REQUIREMENTS: \$50 by check, VISA, or MasterCard credit cards. No other credit cards will be accepted. PLEASE SUPPLY THIS INFORMATION ON THE REVERSE together with mailing address for confirmation of room reservation.

Order of choice	Numbers in parentheses indicate location on map.	Single	Double	Twin double	Triple 2 beds	Triple 2 beds w/cot	Quad 2 beds	Quad 2 beds w/cot	Suite Information
	San Antonio Marriott (1) (Headquarters Hotel)	\$60	\$60	\$60	\$66	\$66	\$70	\$70	\$125 - \$300
	The Crockett Hotel (2)	\$54	\$54	\$54	\$59	N/A	\$59	N/A	\$150
	Hilton Palacio del Rio (3)	\$60	\$60	\$60	\$66	\$66	\$70	\$70	On request
	Holiday Inn Downtown--Market Square (4)	\$47	\$47	\$47	\$47	\$47	\$47	\$47	N/A
	Hyatt Regency San Antonio (5)	\$62	\$68	\$68	\$75	\$90	\$75	\$90	\$150 - \$411
	La Mansion del Rio Hotel (6)	\$60	\$70	\$70	\$80	\$80	\$80	\$80	On request
	La Quinta Convention Center Motor Inn (7)	\$46	\$56	\$56	\$61	\$61	\$66	\$66	N/A
	La Quinta Market Square Motor Inn (8)	\$37	\$45	\$45	\$49	N/A	\$49	N/A	N/A
	Travelodge on the River (9)	\$43	\$46	\$46	\$49	\$49	\$52	\$52	\$90

I will arrive on (date) _____ at _____ a.m./p.m., and depart on (date) _____ at _____ a.m./p.m.

List other room occupants:

FULL NAME

ARRIVAL DATE

DEPARTURE DATE

MAA MINICOURSE PREREGISTRATION FORM, SAN ANTONIO, TEXAS

Please complete this form and return it to

Mr. John Gilliland
 Mathematical Association of America
 1529 Eighteenth Street, NW, Washington, DC 20036
 Telephone: 202-387-5200

DEADLINE: Preregistration deadline for Minicourses: November 15, 1986 (Send form to address above.)
 CANCELLATIONS: 50% of Minicourse fees will be refunded in Washington for cancellations received on or before January 12, 1987. No refunds will be made after this date.

NOTE: All Minicourse registration fees paid to MAA by professional mathematicians are tax deductible.

IMPORTANT: Please be sure to send a separate Joint Meetings preregistration form and fee to the Mathematics Meetings Housing Bureau, PO Box 6887, Providence, RI 02940. Preregistration for the Joint Meetings is a requirement in order to participate in the MAA Minicourses.

[] I plan on preregistering for the Joint Meetings only in order to attend the MAA Minicourse(s) indicated below. 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.

MINICOURSE PREREGISTRATION

1) _____
 (Please print) Surname First Middle

2) _____
 Mailing address for confirmation of Minicourse(s)

3) Employing institution _____

4) Please enroll me in the following Minicourse(s). It is my understanding that an invoice will be sent to me if I have been assigned a place in the course(s) chosen.

 (Signature)

No. MINICOURSES: Participants are limited to two Minicourses each.

- 1 A microcomputer linear algebra course using LIN-KIT (Howard Anton)
- 2 Introduction to computer graphics (Joan P. Wyzkoski, Fairfield University)
- 3 The teaching of applied mathematics (Gilbert Strang, Massachusetts Institute of Technology)
- 4 Interesting applications of elementary mathematics (JoAnne S. Growney, Bloomsburg University)
- 5 Discrete mathematics using difference equations (James T. Sandefur, Jr., Georgetown University)
- 6 Using microcomputer software in teaching calculus (David A. Smith, Benedict College, and David P. Kraines, Duke University)
- NOTE: There is no Minicourse #7.
- 8 Computer simulation of discrete systems (Zaven A. Karian, Denison University)
- 9 Recurrence relations (Margaret Barry Cozzens, Northeastern University)
- 10 Integrating history into undergraduate mathematics courses (Judith V. Grabiner, Pitzer College)
- 11 Teaching mathematical modeling (Maurice D. Weir, Naval Postgraduate School, and Frank R. Giordano, US Military Academy)
- 12 True BASIC in freshman calculus (James F. Hurley, University of Connecticut)
- 13 For all practical purposes (Solomon A. Garfunkel, COMAP, Inc.)
- 14 Applications of discrete mathematics (Fred S. Roberts, Rutgers University)
- 15 Constructing placement examinations (John W. Kenelly, Clemson University)

First choice: [] Second choice: []

MINICOURSE FORM

Mathematical Sciences Employment Register

January 1987 Meeting in San Antonio

The Mathematical Sciences Employment Register (MSER), held annually at the Joint Mathematics Meetings in January, provides opportunities for mathematical scientists seeking professional employment to meet employers who have positions to be filled. Job listings (or descriptions) and résumés prepared by employers and applicants are displayed at the meeting for the participants so that members of each group may determine which members of the other group they would like to have an opportunity to interview. A computer program assigns the appointments, matching requests to the extent possible, using an algorithm which maximizes the number of interviews which can be scheduled subject to constraints determined by the number of time periods available, the numbers of applicants and employers, and the pattern of requests. The report below outlines the operation of the register, indicating some of the procedures involved for the benefit of those not familiar with its operation.

The Mathematical Sciences Employment Register is apparently unique among employment services offered by professional organizations in the sciences, engineering and the humanities. The computer programs used are constructed around a matching program, devised by Donald R. Morrison, and based on an algorithm described in his paper "Matching Algorithms" in *Journal of Combinatorial Theory*, volume 6 (1969), pages 20 to 32; see also "Matching Algorithms" (abstract) *Notices*, August 1967, page 630. The number of interviews arranged by the program is significantly greater than the number possible at the employment registers of other organizations, in many cases greater by an order of magnitude.

1987 Employment Register in San Antonio

The Employment Register will take place in the South Banquet Hall, San Antonio Convention Center on Wednesday, Thursday, and Friday, January 21, 22, and 23, 1987. A short (optional) orientation session will be conducted by the AMS-MAA-SIAM Committee on Employment Opportunities at 9:00 a.m. on Wednesday, January 21. The purpose of the orientation session is to familiarize participants with the operation of the Register and with the various forms involved. Following orientation, participants should pick up their material for participating in the Employment Register. Computer-scheduled interviews will be held on Thursday and Friday, January 22 and 23. **No interviews will be held on Wednesday.**

Fifteen-minute intervals are allowed for interviews, including two or three minutes between successive interviews. The interviews are scheduled in half-day sessions: Thursday morning and afternoon, and Friday morning and afternoon, amounting to four half-day sessions for interviews. There are ten time periods (9:30 - 11:45 a.m.) in which interviews can be scheduled in the morning and fourteen time periods (1:15 - 5:00 p.m.) in the afternoon. It is possible that an applicant or employer may be scheduled for the maximum number of interviews in a session. Requests for interviews will be accommodated depending on the availability of participants. The scheduling program does not have a provision allowing participants to specify particular times for interviews beyond the

choice of session (day, and morning or afternoon). Such requests cannot be accommodated.

Requests for interviews taking place during the two sessions on Thursday MUST BE SUBMITTED on Wednesday between 9:30 a.m. and 4:00 p.m. Requests for interviews to take place during the Friday sessions must be submitted on Thursday before 4:00 p.m. Those who fail to do so cannot be included in the pool of available participants when the matching program which schedules the interviews is run on the computer that night. This applies to all employers and applicants both preregistered and on-site registrants. Forms submitted with preregistration achieve registration for the Employment Register only. These forms do not automatically include the participant in the interviewing process. The interview request forms handed out at the Employment Register must be turned in before the 4:00 p.m. deadline in order to receive a computer printed schedule the next day.

On Thursday and Friday mornings at 9 a.m. all schedules for applicants and employers for the day (both morning and afternoon sessions) will be available for distribution in the South Banquet Hall.

The Friday afternoon session is the annual "employers' choice" session. For this session interviews will be scheduled on the basis of requests made by employers. Applicants do not submit specific interview requests for this session; but, in order to participate they must indicate their availability for the session by returning the Interview Request Form for Friday, indicating that they will attend the afternoon session that day.

Applicants should be aware of the fact that interviews arranged by the Employment Register represent only an initial contact with employers, and that hiring decisions are not ordinarily made during or immediately following such interviews. **Applicants are advised to bring a number of copies of their vitae or résumés so that they may leave them with prospective employers.**

The Mathematical Sciences Employment Register is sponsored by the American Mathematical Society, the Mathematical Association of America, and the Society for Industrial and Applied Mathematics;

Background of Applicants

Statistics from previous Employment Registers have shown employers sought to fill approximately 180 positions, 10 of which were nonacademic jobs. For 98% of the positions, holders of doctoral degrees were preferred, for 65% of the positions only applicants with doctorates were acceptable, for 30% of the positions, holders of masters degrees were considered eligible. Few of the nonacademic employers indicated an interest in holders of bachelors degrees in mathematics.

it is operated by members of the AMS staff under the general supervision of the joint AMS-MAA-SIAM Committee on Employment Opportunities.

Anyone with questions about the Employment Register should contact Carole Kohanski at the American Mathematical Society at 401-272-9500, extension 286. The telephone number to be used after the Register begins will be announced later. Participants should 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. Those who wish to leave messages should call the message center telephone number found in the San Antonio meeting announcement.

Preregistered Employers/Applicants

Preregistration for the Mathematical Sciences Employment Register **must be completed by November 15, 1986**. Applicants and employers (including all interviewers) who wish to preregister for the Employment Register must also register for the Joint Mathematics Meetings. Forms for preregistration, housing, the applicant résumé form, and the employer form are located in the back of this issue. Preregistration for the Employment Register, in addition to permitting inclusion in the printed winter lists of Applicants and Employers, has the advantage of reduced fees and the services of the Mathematics Meetings Housing Bureau, and has the further advantage of helping to reduce waiting times at the meeting in San Antonio.

Employer or Applicant forms received after the November 15 deadline **cannot** be included in the printed lists. For details on registration and preregistration for the San Antonio Joint Mathematics Meetings, please refer to the information on these subjects which may be found elsewhere in this issue.

Employers and applicants who have preregistered for the Employment Register may pick up their MSER material after 9:30 a.m. on Wednesday, January 21, in the South Banquet Hall. **(This material includes the interview request forms which are handed out at the meeting only.)** These are not the forms that are submitted with preregistration. Material for the Employment Register will not be mailed in advance.

Preregistered Applicants

In addition to the Joint Meetings preregistration fee, there is an applicant fee of \$15 payable prior to the November 15 deadline. These fees must be accompanied by the Preregistration/Housing Form.

Applicants' résumés will be made available to employers at the Employment Register in printed form, so that they may be studied carefully at leisure. The December issue of *Employment Information in the Mathematical Sciences* (EIMS) will contain photographic reproductions of the résumés of applicants who have preregistered **by November 15**. Forms not received in time cannot be included in this issue. **See the section on preparation of résumés elsewhere in this announcement.**

Employers' job listings and applicants' résumés will be posted at the meeting, so that applicants and employers may review them.

Preregistered Employers

In addition to the Joint Meetings preregistration fee there is a \$75 fee for employers, if paid prior to the November 15 deadline. These fees must be

accompanied by the Preregistration/Housing Form. This registration fee for employers covers the cost of a copy of the December Issue of *Employment Information in the Mathematical Sciences* (EIMS). This publication contains printed copies of the résumés of applicants who preregistered prior to the deadline; it also contains a copy of the Winter List of Applicants. **It is requested that employers submit both employer and Preregistration/Housing Forms with appropriate fees in the same envelope. It would also be helpful if the names of cointerviewers would be listed on the employer form. If possible, these individuals should also preregister at the same time.**

It is the policy of some institutions to pay for employer fees. These payments do not always accompany the preregistration forms but are sent in after the deadline has passed, or when the meeting is over. It is important that the institution's fiscal department indicate the name of the participating employer so that proper credit can be made in Providence.

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 and names of interviewers for whom simultaneous interviews may be scheduled. Note that all interviewers are expected to register for the Joint Meetings.** (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 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.

A coded strip at the bottom of the form summarizes the information on each form. All employers are required to complete the Summary Strip. This is used to prepare a computer-printed list of preregistered employers for distribution to the applicants.

Nonpreregistered Applicants and Employers

Employers and applicants who wish to participate in the Register who have neither preregistered nor paid the Employment Register fee must first go to the Joint Mathematics Meetings registration desk in the North Banquet Hall, San Antonio Convention Center in order to complete their registration. **No provision will be made to handle cash transactions at the site of the Employment Register.** Registration for the Joint Meetings is required for participation in the Employment Register. It is also required that all participating employer interviewers register for the Joint Mathematics Meetings.

Onsite registration for the Employment Register is \$100 for employers and \$20 for applicants. This registration fee for employers covers the cost of a copy of the December Issue of *Employment Information in the Mathematical Sciences* (EIMS). This publication contains printed copies of the résumés of applicants who preregistered prior to the deadline and a copy of the Winter List of Applicants.

After registration has been completed, applicants and employers should come to the South Banquet Hall to fill out the forms necessary to participate in the Employment Register.

Nonparticipating Employers

Employers who do not plan to participate in the Employment Register, but wish to display job descriptions, may obtain special forms from Carole Kohanski, MSER, P. O. Box 6248, Providence, RI 02940. These job descriptions, subject to approval, must be received in the Providence office by **November 15** in order to qualify for the reduced fee of \$10. There is a \$15 fee for listings received after the November 15 deadline.

Employers who attend the Joint Mathematics Meetings but do not want to interview, can post job descriptions, subject to approval, at the Employment Register. Postings will not be allowed in the Joint Meetings registration area. A fee of \$15 will be charged payable to the cashier at the Joint Mathematics Meetings registration desk. Participants should be sure to inform the cashier that they would like to post a job description but are not planning to interview and obtain the proper receipt in order to receive the form necessary for posting at the Employment Register desk.

Applicants Not Planning to Attend

Applicants for professional positions in the mathematical sciences, who do not plan to attend the meeting in San Antonio and participate in the Employment Register, may also submit résumés for publication in the December issue if they use the MSER Form for Applicants at the back of this issue and observe the deadline of November 15. **(It is, of course, not necessary to preregister for the meeting or pay the Employment Register registration fee if one is not attending the meeting. Résumés will not be posted at the Employment Register if the participant is not attending the meeting.)**

Winter Lists of Applicants and Employers

The Winter List of Applicants, which is a summary of the résumés of preregistered applicants, will be available for sale at the AMS Exhibits and Book Sale at the meeting. The price at the meeting is \$4 each. Any copies remaining after the meeting will be available from the Providence office of the Society for \$6 each.

The Winter List of Employers consists of summaries of the position listings submitted by the employers who preregistered for the meeting; it will be distributed to the applicants participating in the Register. Others may purchase the Winter List of Employers at the AMS Exhibits and Book Sale at the meeting or from the Providence office after the meeting. The prices are the same as stated in the previous paragraph.

Please note that these lists will not be updated with onsite employers or applicants after the Employment Register has concluded.

December Issue of Employment Information in the Mathematical Sciences

For several years the periodical *Employment Information in the Mathematical Sciences* (EIMS) has published six issues per year listing open positions in academic, governmental and industrial organizations, primarily in North America, along with a few listings from countries in other parts of the world. EIMS is a joint

project of the American Mathematical Society (publisher), the Mathematical Association of America, and the Society for Industrial and Applied Mathematics.

The December issue of EIMS contains résumés of persons seeking professional positions in the mathematical sciences. Résumés of applicants taking part in the Employment Register and those not attending will be included in the December 1986 issue provided they were received before the November 15 deadline and are in satisfactory condition. Other mathematical scientists who wish to be included may have their résumés printed if the same deadline is observed and if the copy supplied meets the same technical requirements described in the following section.

Copies of the December issue of EIMS will be distributed in San Antonio to the employers who participate in the Employment Register.

Job applicants planning to participate in the Employment Register in San Antonio are therefore strongly urged to preregister so that their résumés can appear in the December issue.

Please note that the December issue of EIMS contains the Winter List of Applicants, but does not contain the Winter List of Employers.

Additional copies of the December Issue of EIMS will be available for sale at the AMS Exhibits and Book Sale at the meeting. Prices at the meeting are \$7 each for the December issue. Any copies remaining after the meeting will be available from the Providence office of the Society for \$12.

Preparation of Applicants' Résumés for the December issue of EIMS

The December issue of EIMS will be printed using photographic reproductions of forms completed and submitted by applicants. For this reason, special care must be exercised by those who prepare the forms in order to assure that the results are of good quality, and will be clear and legible after they have been photographed, reduced in size, and printed.

Because an employer's first impressions of an applicant are likely to be based on the appearance of the printed form, applicants are strongly advised to study the suggestions given below before the forms are filled out, so that the original copy will be neither marred nor damaged.

The forms **must be** carefully typed using a new black ribbon. The best results are obtained by using a modern typewriter with a carbon-coated polyethylene film ribbon, but satisfactory results may be obtained with 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, which must be a uniform dark black. Gray, blue, or other colors will not reproduce and should, therefore, not be used. Do not use an eraser, as it will cause smudges which reproduce when photographed. Use a correcting typewriter, or correction tape or fluid, if necessary.

Only an original copy of the form should be submitted, a photocopy or xerographic reproduction will not reproduce as well and may not be accepted for publication. It is therefore important to exercise care in order to assure that the results are satisfactory.

Submission of copy of good quality is entirely the responsibility of the applicant. The Society (which will print this material) must be the final judge of what copy is capable of being reproduced adequately,

(continued on page xxv)

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 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 San Antonio meeting announcement.)**

EMPLOYER FORM Institution _____ Dept. _____

Name of Interviewer(s) 1. _____ 2. _____

3. _____ 4. _____

City, State, Zip _____

(A) Title(s) of Position(s) _____ (B) Number of Positions _____ Number of People Supervised _____

(C) Starting Date _____/_____/____ yr. Salary _____ (D) Term of Appointment _____ yrs. (E) Renewal () Possible () Impossible () Unknown ()

Teaching hrs./week _____ F Specialties Sought _____

(G) Degree Preferred _____ (H) Degree Accepted _____ (I) Duties _____ (J) Experience _____ (K) Citizenship Restriction _____

(L) Available for Interviews Session 1 () Thurs. AM, 9:30-11:45 Session 2 () Thurs. PM, 1:15-5:00 Session 3 () Fri. AM, 9:30-11:45 Session 4 ()* Fri. PM, 1:15-5:00

(M) Number of Interviewers: _____ Interviewers _____ Interviewers _____ Interviewers _____

Institution _____ City _____ State _____ Title of position _____ (N) No. _____ (O) Start mo. / yr. _____

(P) Specialties sought _____ (Q) Experience _____ (R) Sessions _____

NOTES: (A) Inst, Lect, Asst Prof, Asso Prof, Prof, Dean, Open, MTS (Member Technical Staff), OPAN (Operations Analyst), PREN (Project Engineer), RESC (Research Scientist); (B) Date 01/87, e.g.; (C) Possible=P, Impossible=I; (D) Algebra=AL, Analysis=AN, Biomathematics=BI, Biostatistics=BS, Combinatorics=CB, Communication=CM, Control=CN, Computer Science=CS, Circuits=CT, Differential Equations=DE, Economics=EC, Mathematical Education=ED, Functional Analysis=FA, Financial Mathematics=FI, Fluid Mechanics=FL, Geometry=GE, History of Mathematics=HM, Logic=L, Mathematical Biology=MB, Mechanics=ME, Modeling=MO, Mathematical Physics=MP, Management Science=MS, Numerical Analysis=NA, Number Theory=NT, Operations Research=OR, Probability=PR, Systems Analysis=SA, Statistics=ST, Topology=TO; (G) Bachelor=B, Master=M, Doctor=D; (H) Teaching=T, Undergraduates=U, Graduates=G, Research=R, Consulting=C, Administration=A, Supervision=S, Industry=IND, Government=GOV, Data Processing=DP, No experience required=N; (K) U.S. Citizen=C, U.S. Citizen or permanent resident=CP, No restriction=NR; (L) 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.

MATHEMATICAL SCIENCES EMPLOYMENT REGISTER

(continued from page xxii)

and therefore of what is acceptable for inclusion in the printed booklet. The Society will not correct or replace inadequate copy, and cannot prepare original copy. In the event the quality of a résumé, submitted by an applicant participating in the Employment Register, does not meet the necessary conditions for inclusion in the December issue, the résumé will be returned if time allows; otherwise the résumé will be posted at the Employment Register in San Antonio, along with those of the other participants. **Forms received past the deadline will be returned.**

List of Retired Mathematicians Available for Employment

The annual *List of Retired Mathematicians* will be included in the December and January issues of the publication *Employment Information in the Mathematical Sciences*. Retired mathematicians who are interested in being included in the list may send the following information to the Mathematical Sciences Employment Register, American Mathematical Society, P. O. Box 6248, Providence, Rhode Island 02940.

1. Full Name
2. Mailing Address
3. Highest degree, year, university
4. Most recent employment: institution
5. Type of position desired
6. Academic or industrial employment preferred
7. Date available for employment (month/year)
8. Geographic location preferred

The deadline for receipt of this information is **November 15**. Offprints of the list will be available from the Mathematical Sciences Employment Register, American Mathematical Society, P.O. Box 6887, Providence, Rhode Island 02940.

Instructions for Applicant's Form on facing page

The form. Applicants' forms submitted for the Employment Register will be photographically reproduced in the December 1986 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 15, 1986** 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. **See the Meeting Announcement in this issue for information. 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	

(H) (I) Duties

T = Teaching	U = Undergraduate
G = Graduate	R = Research
C = Consulting	A = Administration
S = Supervision	IND = Industry
GOV = Government	DP = Data Processing

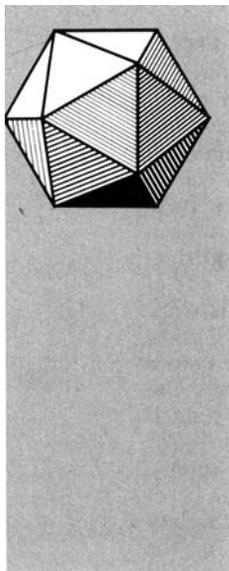
Location

E = East	S = South
C = Central	M = Mountain
W = West	O = Outside U.S.
	I = Indifferent

(L) U.S. Citizenship Status

C = U.S. Citizen	P = Permanent Resident
T = Temporarily in U.S.	N = Non-U.S. Citizen

New in the MAA Studies Series



STUDIES IN MATHEMATICAL ECONOMICS

Volume #25 MAA Studies in Mathematics
 Edited by Stanley Reiter
 420 pp. Cloth. ISBN-0-88385-027-X
 List: \$42.00 MAA Members: \$31.00

“For the mathematician desiring to become familiar with modern mathematical, microeconomic theory, this volume is indispensable.”
 Robert Rosenthal, SUNY, Dept. of Economics

STANLEY REITER, as editor, has brought together a distinguished group of contributors in this volume in order to give mathematicians and their students a clear understanding of the issues, methods, and results of mathematical economics. The range of material is wide: game theory; optimization; effective computation of equilibria; analysis of conditions under which economies will move to the greatest possible efficiency under various forces and the requirements for the flow of information needed to achieve efficient markets.

The material is interesting at all mathematical levels. For example, the initial article shows how even mathematically simple, concrete, two-person, nonzero sum games present us with the complexities and dilemmas of choices in real life. At the other extreme, the final article, by Debreu, begins by using the power of Kikutani's fixed point theorem to prove the existence of economic equilibria. In between, the reader will find beautiful uses of calculus, topology, combinatorial topology, and other topics. Each of these papers provides a clear path to the center of its subject, with extensive references should the reader wish to explore further.

The chapters of this volume can be read independently although they are related. The book begins with Meyerson's chapter on game theory and its theoretic foundations. The second chapter, by Simon, starts with the familiar criteria for maxima from calculus and goes on to develop more general tools of mathematical economics, including the Kuhn-Tucker and related conditions. The third contribution, by Mas-Colell, uses the tools of differential topology, including Sard's theorem, to study the competitive equilibria of whole families of economies, using a differentiable point of view. Next, Kuhn, building on the work of Scarf, shows how methods based on Sperner's lemma can be used to compute equilibria.

The next two chapters by Reiter and Hurwicz explore the properties of systems that are purely competitive. They bring analytical and topological tools to bear to determine what conditions on the exchange of information are needed to allow such markets to become optimally efficient.

Radner addresses one consequence of what Herbert Simon calls "bounded rationality". Managers neither know all the facts nor do they have unlimited ability to cal-

culate. How should they allocate their time? Radner examines the consequences of two strategies: "putting out fires", or setting up expected ranges of performance for various activities and only managing them when they are off target. His tools are fittingly probabilistic, for the evidence is that performance itself is a stochastic variable.

In the final paper, Debreu gives four examples of mathematical methods in economics. These four examples alone give a sense of the breadth and nature of the field. Of them Debreu says ". . . the techniques used . . . are indispensable for the mathematical study of social systems: algebraic topology for tests of existence; differential topology for the more demanding tests of discreteness and continuity; combinatorial techniques for computation, and measure theory for the study of large sets of small agents."

Reiter states in his Preface, "Economics involves complex and subtle relationships among large numbers of variables. Mathematics is the natural way of ensuring the precise, clear, and definite formulation of (economic) ideas . . ."

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Just Published in the MAA's New Mathematical Library

International Mathematical Olympiads, 1978-1985 and Forty Supplementary Problems,

compiled and with solutions by Murray S. Klamkin
New Mathematical Library # 31
160 pp. Paper. ISBN-O-88385-631-X
List: \$11.50 MAA Member: \$9.20

Since 1959, nations from around the world have been competing in the International Mathematical Olympiads. Begun as a competition among Eastern European nations, the IMO has grown steadily to become a world summit meeting of high school mathematical problem solvers. The United States has been participating since 1974 and has become a strong contender in the competition placing first in 1977, 1981, and 1986. IMO '81 was hosted by the U.S. for the first time in the history of the competition.

Murray S. Klamkin and Samuel L. Greitzer were the dedicated coaches who led the U.S. teams to capture top honors at the Mathematical Olympiads from 1974-1984. Professor Greitzer, long-time champion of U.S. participation in the IMO compiled the first collection of Olympiad competitions covering the years 1959-1977. Murray S. Klamkin, master problemist and coach to the U.S. team from the beginning of U.S. participation in the competition until 1984 has collected the 42 problems from the seven most recent Olympiads, and has added 40 additional representative problems submitted by various participating countries, but not used in the competition.

Detailed solutions to all problems are included, some supplied by the contestants. In many cases several different solutions are offered, and extensions and generalizations are suggested in supplementary notes. There is an extensive glossary and a comprehensive list of references.

The problems are solvable by methods accessible to secondary school students in most nations, but insight and ingenuity are often required. Test your mettle against the IMO competitors.



The Mathematical Association of America
1529 Eighteenth Street, NW
Washington, DC 20036

This is a copy of a message that will accompany all 1986 dues notices.

*Last chance for tax savings. Life membership
open to all now through December.*

L I F E M E M B E R S H I P

In anticipation of a possible new tax law to take effect in 1987, the Association announces a broadening of eligibility for Life Membership.

Here are the facts:

FACT 1. Congress has passed the Tax Reform Act of 1986 and the President is expected to sign it into law this fall. The new tax law effectively abolishes the deduction for professional dues which is allowed under the current tax code.

FACT 2. The current tax code allows deduction of dues paid for future membership in the year in which the dues are paid.

Recognizing these FACTS, the Association is pleased to make the following offer, effective through December 31, 1986.

- ° Any member may become a LIFE MEMBER of the MAA by a one-time payment of life dues, the amount depending on the member's age on January 1, 1987. See the reverse side for a table of these dues and a Life Membership application form.
- ° Any member may make a non-refundable advance payment of dues for membership in 1987 and future years. Such a payment, which may be in any amount, is fully deductible in 1986. A member who has made an advance payment will receive an annual notification of the balance in his or her advance dues account.

WARNING. Whether an individual member will realize a significant tax saving from payment of Life Dues or an advance dues payment depends on the IRS interpretation of the new tax law and on whether the member itemizes deductions on his or her tax form.

Note the time limitation on the above offer. It has not yet been determined whether life membership will be so broadly available beyond 1987.

Because of FACT 2 it may be advantageous to prepay your MAA dues for a few years even if you do not want to take advantage of the life membership offer.

LIFE MEMBERSHIP DUES*

<u>Age on Jan. 1, 1987</u>	<u>Life Dues</u>	<u>Age on Jan. 1, 1987</u>	<u>Life Dues</u>
60	\$ 550	40	\$1,100
59	590	39	1,120
58	630	38	1,140
57	670	37	1,160
56	710	36	1,180
55	750	35	1,190
54	780	34	1,200
53	810	33	1,210
52	840	32	1,220
51	870	31	1,230
50	900	30	1,240
49	920	29	1,250
48	940	28	1,260
47	960	27	1,270
46	980	26	1,280
45	1,000	25	1,290
44	1,020	24	1,300
43	1,040	23	1,310
42	1,060	22	1,320
41	1,080	21	1,330
		20	1,340

* These life dues approximate the present value of dues paid annually during the expected life of the member, assuming moderate inflation and a reasonable return on invested funds.

TO: Membership Department, MAA
1529 Eighteenth Street, NW
Washington, DC 20036

FROM: _____ (Name) _____ (Member Code)
 _____ (Address)

 _____ (City) _____ (State) _____ (Zip)

I accept your offer of Life Membership beginning in 1987.

My age on January 1, 1987 will be _____.

I enclose my payment of: Dues from table \$ _____
 Less 1987 dues paid earlier (\$ _____)
 =====
 Total amount enclosed \$ _____

(Signed)

The Deadline for submission in the January–February issue is December 1.

FOCUS Employment Advertisements

Rates for FOCUS Employment Ads are:

- 50 words or less: \$25.00
- More than 50 words: \$30 per column inch

There is a 15% discount for the same ad in 3 consecutive issues (with contract in advance). An insertion order on institutional letter head will be considered a contract. Charges will be billed after the first occurrence specified in the contract.

Anyone wishing to place an employment ad in FOCUS should write to: FOCUS Employment Ads, Mathematical Association of America, 1529 Eighteenth Street, N.W., Washington, D.C. 20036. Or for more information, call the MAA Washington Office at (202) 387-5200.

The deadline for submission in the Jan/Feb issue is December 1.

DIRECTOR OF ACADEMIC COMPUTING KENYON COLLEGE

Kenyon College, an undergraduate liberal arts institution with a distinguished reputation for educational excellence, is seeking a Director of Academic Computing to replace the late Robert A. Rennert. The Director, who normally holds faculty rank, serves as the chief administrative officer of the new Olin Computing Center, and provides leadership that encourages the integrated use of academic computing in a liberal arts environment. The Director reports to the Provost and has overall responsibility for all aspects of academic computing, including long range planning, budgeting, provision of services, and staff development and supervision. Teaching in an appropriate academic discipline is welcome but optional. Major facilities include the Olin Computing Center, based upon a VAX 8600, and the Crawford Center for personal computing and graphics; and the College seeks an individual who will capitalize on these facilities to enhance Kenyon's commitment to the integration of computing into the traditional liberal arts.

Qualifications: a Ph.D. in an academic discipline; advanced training in computer science; demonstrated administrative competence; at least three years experience in an academic computing center; demonstrated ability to work congenially with students, faculty, administrators, and staff; a coherent vision of the role of computing in the liberal arts.

Salary open to reflect background and experience. Position available immediately. Send letter of application, resume, transcripts, and at least three professional references to: Provost, Kenyon College, Gambier, OH 43022. The Search Committee will begin reviewing applications on September 1, 1986, and will continue to do so until position is filled. Kenyon College is an Equal Opportunity Employer and encourages applications from women and minority candidates.

The Department of Mathematics at Boston University anticipates an opening for an Assistant Professor in Fall 1987. Preference given to applicants in Applied Mathematics, Dynamical Systems, Statistics and related fields. Women and minorities are encouraged to apply. Send vita and three letters of reference to: Search Committee, Department of Mathematics, Boston University, 111 Cummington Street, Boston, MA 02215.

Senior level appointment in Mathematical Statistics anticipated for Fall 1987. Record of distinguished achievements in research, commitment to excellence in teaching required. Women, minorities esp. encouraged to apply. Send nominations and applications to Search Committee, Department of Mathematics, 111 Cummington St., Boston University, Boston, MA 02215.

Associate of Assistant Professor position in Probability is anticipated for Fall 1987. Demonstrated excellence in research and a strong commitment to teaching at the graduate and undergraduate level required. Candidates with established research records as well as new Ph.D.'s are encouraged to apply. Send vita and three letters of reference to: Professor Murad Taqqu, Probability Position, Department of Mathematics, 111 Cummington St., Boston University, Boston, MA 02215.

AUBURN UNIVERSITY

The Division of Mathematics at Auburn University invites applications and nominations for the position of Coordinator of Undergraduate Mathematics, whose principal concern will be freshman and sophomore mathematics service courses. The Coordinator will be responsible for scheduling teaching assignments, registration of students, oversight of curriculum revisions and textbook selections, administration of course and teaching evaluations, and supervision and evaluation of Graduate Teaching Assistants.

Ph.D. in mathematics and significant undergraduate teaching experience required. Academic rank, eligibility for tenure, and salary commensurate with qualifications.

The Division has approximately 70 faculty members and 40 Graduate Teaching Assistants (in M.S. and Ph.D. programs) in two departments of mathematics. Enrollment in about 475 sections of lower division service courses is approximately 13,000 students annually. The coordinator will hold a 12 month position and be responsible to the heads of the two departments.

Auburn University, located in Auburn, Alabama, is a state land-grant university enrolling more than 19,000 students. The city of Auburn is a picturesque university community located about 120 miles southwest of Atlanta in a region of farms and woodlands.

Women and minorities are encouraged to apply. Send nominations, or applications including resume and names of three references to Robert E. Kribel, Acting Dean, College of Sciences and Mathematics, Auburn University, AL 36849. AUBURN UNIVERSITY IS AN EQUAL OPPORTUNITY, AFFIRMATIVE ACTION EMPLOYER.

MANKATO STATE UNIVERSITY DEPARTMENT OF MATHEMATICS, ASTRONOMY, AND STATISTICS MANKATO, MN 56001

Tenure track faculty position in mathematics available. Rank/salary dependent upon qualifications. Ph.D. in mathematics required. Applicants must have strong background in applied mathematics, strong interest in teaching at freshman through graduate levels, and show evidence of successful teaching at postsecondary level. Teaching load at most 36 quarter hours per 9 month academic year. Successful candidate will teach courses in mathematics and applied mathematics, assist with student advising, serve on various departmental committees, and conduct appropriate research. Open until filled. Send application letter, vita, research and teaching interests, and three (3) letters of reference to F.T. Hannick, Chairperson.

**U.S. NAVAL ACADEMY
Department of Mathematics**

Applications are invited for several tenure-track appointments at the rank of Assistant or Associate Professor commencing in January or August of 1987. The initial salary will be competitive and commensurate with experience and qualifications. Research opportunities exist for augmenting salary during the summer intersessional period. Specialization in applied mathematics or operations research is of particular interest. Applicants must possess an earned Ph.D. by the date of appointment, have a commitment to excellence in teaching, and be capable of pursuing an independent program of research. Inquiries and applications should be sent to Prof. J. M. D'Archangelo, Mathematics Department, U.S. Naval Academy, Annapolis, MD 21402-5002. Required of all applicants are a resume, transcripts of academic records, and at least three letters of recommendation from persons familiar with the applicant's teaching and research. Interviews will be conducted at the annual AMS/MAA meeting in San Antonio in January. The Naval Academy is an EO/AA employer.

LUTHER COLLEGE, DEPARTMENT OF MATHEMATICS, DECORAH, IOWA 52101. TENURE-ELIGIBLE POSITION AT INSTRUCTOR OR ASSISTANT PROFESSOR RANK STARTING SEPTEMBER 1987. Qualifications: Ph.D. or ABD in mathematics. Duties: Teach three classes in mathematics each semester, plus one class in three out of four January terms. Salary: competitive, generous fringe benefits. Closing date is February 20, 1987. Credentials received after this date will be considered if the position has not been filled. Send dossier and 3 letters of reference to: Dr. Donald Pilgrim, Head, Mathematics Department, Luther College, Decorah, Iowa 52101. Phone: 319/387-1173. An EO employer.

**JAMES ACTUARIAL SERVICES
Short Hills, N.J.**

Casualty actuarial consulting offers opportunity to apply mathematical skills to business problems. James Actuarial Services is part of the worldwide insurance brokerage network of Fred S. James & Co., Inc. and its parent, the Sedgwick Group. We are looking for dynamic individuals able to reason analytically, apply mathematical skills, and communicate results. Our actuarial consultants are involved in the financial modeling and evaluation of insurance and risk management programs for corporations, local governments, and associations. For further information, contact Gail Trimble, James Actuarial Services, 830 Morris Turnpike, Short Hills, N.J. 07078, 201/564-7439. Fred S. James & Co., Inc. is an Equal Opportunity Employer.

**Mills College
Department of Mathematics and Computer Science
Oakland, California 94613**

Mills College is seeking outstanding candidates for a tenure-track position as Assistant, Associate or Full Professor of Mathematics commencing Fall, 1987. Successful candidates must have demonstrated superior teaching and research abilities and a commitment to become involved in a highly innovative and energetic department. Rank and salary will depend on experience and qualifications. The initial contract will be for three years, subject to administrative approval. Mills College is an Affirmative Action/Equal Opportunity Employer.

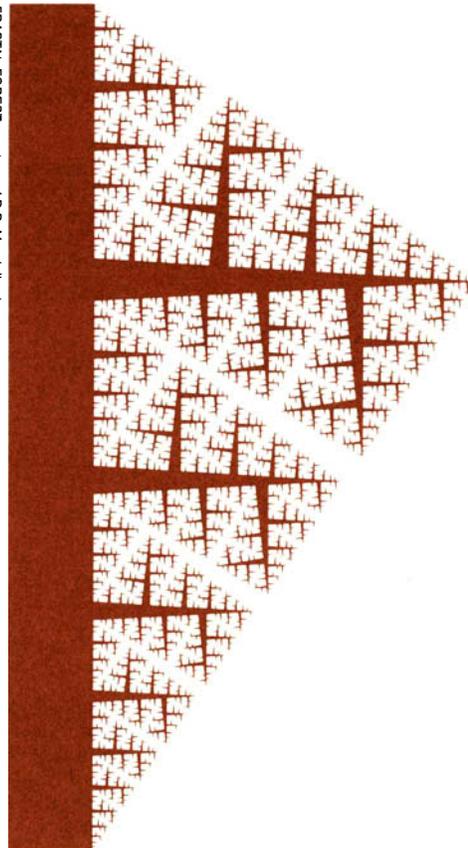
Send vita and direct three letters of reference to:

Professor Diane McEntyre
Mathematics Search Committee
Mills College
Oakland, CA 94613

Help the MAA grow and earn credit for your MAA account.

Vigorous efforts in the last few years have brought our membership from below 19,000 to about 25,000. We know that our strongest supporters are among our present members and that they know the most about the benefits of membership and are in touch with many of the best candidates for membership; hence, we are urging our members to help us enroll new members. The MAA must regularly seek new members for many reasons: as sources of new ideas and the energy to move existing programs ahead, to share the benefits of membership as widely as possible and to distribute the costs as broadly as possible; and to carry out its primary mission of promoting mathematics. To add to the rewards of virtue, the MAA will credit any existing member's account with ten dollars for each new member he or she brings to the MAA in this campaign. To ensure proper credit to his or her account, a current member must use a copy of the form on the back of this page when enrolling new members.

FRactal Forest courtesy of B.B. Mandelbrot



Help the MAA Grow. See back of this page.

This complete form with current member's name below must be returned to receive proper credit.

name _____

address on MAA records _____

(SEE FOCUS LABEL) _____

address _____

city _____

state _____ zip _____

MAA customer code (above name of FOCUS Label) _____

CATEGORIES OF MEMBERSHIP

ALL MEMBERS

From the bylaws of the Association:

Art. II, Sec. 2. Any person interested in the field of collegiate mathematics shall be eligible for election to ordinary membership in the Association.

Sec. 4. Election to membership shall be by vote of the Board upon written application from the individual . . . seeking admission. In the case of individuals qualifying for student dues the application shall be endorsed by two ordinary members of the Association.

Art. VII, Sec. 1. The Board shall establish the annual dues and privileges of membership for ordinary . . . members. The dues of ordinary members shall include a subscription to one of the official journals.

The Board has set the **annual dues** for ordinary members at the rates specified on the form.

The membership year is a calendar year. Members entering the Association between November 1 and March 31 should send one year's dues with this application; Journals will be sent beginning with the nearest January issue.

Members entering between April 1 and October 31 may, if they wish, send a payment covering dues for one and one-half years, at the appropriate rate; Journals will then be sent beginning with the nearest June issue.

STUDENT MEMBERSHIP

Student Membership is available to high school and undergraduate students and students regularly enrolled in graduate study at least half-time.

Applicants for Student Membership must be nominated by two members of the Association. Nomination implies affirmation that the applicant qualifies for this special membership under the definition stated above.

NOMINATION FOR STUDENT MEMBERSHIP

We the undersigned members of the Association
recommend that this application for
Student Membership be approved.

Print name: _____

Signature: _____

Print name: _____

Signature: _____

UNEMPLOYED MEMBERSHIP

Unemployed rates are also available on request to unemployed mathematicians for a period of up to two years. The unemployed status refers to anyone currently unemployed and actively seeking employment. It is not intended to include members who have voluntarily resigned or retired from their latest position. To request these rates as an unemployed member applicant should enclose a letter stating that he/she meets the above criteria.

NEW MEMBER'S APPLICATION

Mail to:

The Mathematical Association of America • Tel: 202 387-5200
1529 Eighteenth Street, Northwest, Washington, DC 20036

I hereby apply for membership in the Mathematical Association of America.

I have have not been a member of MAA before
(maiden name _____).

PLEASE PRINT CLEARLY

TITLE, FIRST NAME, MIDDLE INITIAL, LAST NAME

ADDRESS FOR ALL MAIL

CITY, STATE/PROV, ZIP/POSTAL CODE

DATE OF BIRTH

HIGHEST EARNED DEGREE, YEAR AWARDED, AWARDING INSTITUTION

CURRENT POSITION (OR "STUDENT")

EMPLOYER (OR STUDENT'S INSTITUTION)

EMPLOYERS CITY, STATE

Membership Fees

All MAA members receive *FOCUS*, the Newsletter of the Mathematical Association of America. Subscription prices are included with dues.*

Journal Options/Membership Fees

CIRCLE the appropriate number in the table below and write the amount below.

M = The AMERICAN MATHEMATICAL MONTHLY
G = MATHEMATICS MAGAZINE
J = COLLEGE MATHEMATICS JOURNAL

Line	M	G	J	M+G	M+J	G+J	M+G+J
Regular	\$40.00	\$28.00	\$31.00	\$52.00	\$55.00	\$43.00	\$67.00
Student	\$24.00	\$18.00	\$20.00	\$30.00	\$32.00	\$26.00	\$38.00

Student memberships require special certification and approval. See left column.

Amount paid \$ _____ (fill in)
Method of payment (U.S. funds only please)

Check.

Credit Card. Type _____

Card Number (Please show blanks)

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Expiration date ____/____

Signature _____

*Annual dues include annual subscription prices as follows: Reg Memb. \$24 (M), \$15 (J), \$12 (G), \$1 (Focus). Std. Memb. \$12 (M), \$8 (J), \$6 (G), \$1 (Focus).

George Putnam and the Putnam Tradition Honored at the 25-year Member Dinner

The 25-year member dinner held at the Sheraton Palace Hotel in San Francisco on August 2 honored not only long-time members of the MAA but also the long tradition of the William Lowell Putnam Mathematical Competitions and George Putnam as representative of the support that the Putnams have given to these competitions that date from 1938.

Because the dinner honored George Putnam, the invitees included a number of Putnam contestants. The MAA member of longest standing at the dinner was Professor Carolyn Eisele of Hunter College who joined in 1925. She was at the ICM to present her paper "Peircean Thought on Mathematical Logic." Professor Richard D. Schafer was present and served to represent the participants in the first Putnam Contest. Both these people were awarded MAA books as prizes.

The MAA's certificate of merit for George Putnam reads in part:

As a native of Manchester, Massachusetts, and member of a family distinguished by its service and a long tradition of majoring in mathematics at Harvard, George Putnam was graduated magna cum laude in 1949 from Harvard College, then went on for his MBA at Harvard Business School.

He has served as an officer and director of a number of professional associations and on the boards of numerous American corporations. Further, he has served education, science, and the arts as a trustee of Wellesley College, Bradford College, the Boston Science Museum, the New England Aquarium, and the Museum of Fine Arts, Boston, among many others. Until recently he was treasurer of his *alma mater*, Harvard University.

In his position as trustee of the Putnam Intercollegiate Memorial Fund, he has generously supported the William Lowell Putnam Mathematical Competition which, since 1938, has always challenged—and occasionally perplexed—undergraduate students of mathematics. Ever anxious to enhance and widen the participation of American and Canadian students, he has seen during his trusteeship a considerable growth in the influence of the Competition.

George Putnam's written reply gave a sense of this long-term effort from the family's point of view and of its appreciation for the help of the mathematical community in making these competitions possible. He wrote:

On behalf of four generations of the Putnam Family, please express our humble gratitude for the great honor being paid to us, which I am grateful to accept:

- on behalf of my grandfather, whose idea for an intercollegiate competition in other than athletics provided the inspiration for the Putnam Competition;
- on behalf of my grandmother who in her will created the fund in honor of her husband which gave it substance;

- on behalf of my father and his brother Augustus, who brought it into being and whose investment prowess built the Prize Fund;
- and on behalf of my son George III, who is carrying his share of responsibility today and will help to guide it through his own generation and will, I hope, encourage his son (another W. L. Putnam, known as Lowell, now age four) to take up the cudgel.

We are also deeply grateful to those wise Harvard mathematicians who long have advised the trustees, two generations of Birkhoffs—George and Garrett, and for many recent years, Andrew Gleason, himself a Putnam winner. Finally, the trustees are deeply indebted to the AMA for providing guidance and sponsorship and for bringing to this competition a series of distinguished directors, especially our current director Professor Leonard Klosinski, without whose hard work and leadership the Competition could never take place each year.

The early Putnams would be astounded by the success of their idea and the role the competition has come to play. The generations to come must be careful to see that it continues to be a lively, viable and useful contribution to society in encouraging young men and women to test themselves in scholarship primarily for the sake of pleasure, intellectual stimulation and friendly competition among institutions, which it was intended to provide, and I hope does.

IFRICS Expands

The Institute For Retraining In Computer Science (IFRICS) will extend its activities during Summer 1987, its fifth year of operation. The IFRICS program has consisted of two summers residence (eight weeks each) at either the Clarkson or Kent State campus. Each summer the participants take eight one-month courses. During the intervening year, participants teach at least one computer science course and complete a large programming project as part of their training.

The curriculum includes programming, theoretical computer science, data structures, advanced programming with a comparative study of programming languages, machine architecture and assembly language, compiler construction, and operating systems. These are taught by computer scientists drawn from active departments.

In 1987, the program will be extended and made more flexible. Applicants with stronger backgrounds can take the second half of the program in a single summer, and people with special needs can arrange special programs to cover just those courses appropriate for them. Additional one-month courses will be offered that can be taken separately. New courses offered in 1987 will include computer-based discrete mathematics.

In four years IFRICS has given computer science training to nearly 250 college professors, by using its total immersion program which allows rapid progress to a high standard of achievement.

For more information, contact:

Ed Dublinsky

Mathematics and Computer Science Department
Clarkson University
Potsdam, New York 13676

Zero-Knowledge (continued from page 1)

of X modulo N (i.e. an integer x such that x^2 leaves a remainder of X when divided by N). This knowledge is analogous to Alice knowing the proof of a specific theorem. For prime N this "proof" is known to be easy to construct, but in general it seems that the difficulty of finding a square root is equivalent to the difficulty of factoring N . The problem of factoring is quite possibly inherently difficult; certainly at this time no feasible general scheme is known (at least publicly) to factor 150 digit numbers.

In order for Alice to now convince Bob that she knows the square root x , i.e. a "proof", a dialogue between Alice and Bob now ensues. First A prepares a random integer Y that she knows to be a square modulo N (this is easy--she chooses a random y and squares it modulo N). A tells B this integer. Then it is B's turn. He can ask one (but not both) of the following questions: 1) "What is the square root of Y ?" or 2) "What is the square root of XY ?". A answers the question and B then verifies the answer. This process continues k times—A prepares an integer Y , B chooses question 1 or question 2, A answers the question, and B checks the answer.

Note that A can easily answer either question correctly if she possesses both square roots, x and y . Also, B can easily verify the correctness of the answers by squaring since he knows X , Y , and N . Note that it is (at least intuitively) clear that B gains no information about x from the answer to (one of) questions 1 and 2; B has merely learned the square root of a random integer modulo N (note that if Y is random then XY is also random).

What if A cheats, saying that she knows the square root when she doesn't? She could bluff by preparing an answer to question 1 and hoping that B chooses that option. Or she could guess that B will choose question 2 and bluff by preparing her Y to be of the form y^2/X since it is then easy to answer question 2 (but not question 1) correctly. Thus, after one round in which A has answered B's question correctly it is reasonable for B to assume that there is a probability of $1/2$ that A knows the proof. However, after k rounds in which A answers all questions correctly B must conclude that A knows the square root of X with probability $1-(1/2)^k$. Thus the argument that A knows a proof is *probabilistic*. However, for $k=100$, B is surely forced to conclude that there is a negligible chance that A is bluffing, although perhaps B is not convinced that the theorem has a "proof" with the same absolute (?) certainty that would come from B's being able to check the details of A's proof himself.

In this procedure it is important for A to choose each Y randomly and independently; otherwise B might learn something about x . As an extreme case, if B gets to ask **both** question 1 and question 2 for the same Y then a simple division produces x . In order to prove that the above scheme communicates no information if A chooses randomly, the intuitive idea of a communication procedure for a zero-knowledge proof needs to be formalized; this was done by Goldwasser, Micali, and Rackoff.

These developments are intertwined with the basic ideas of computational complexity. For instance, it is necessary to show that the computations required are "easy" in the standard sense that they take an amount of time bounded by a polynomial in the size of the input instance (i.e. they are in the class P). On the other hand, it is necessary to assume that certain computations (such as factoring integers) are practically impossible for sufficiently large input.

Goldreich, Micali, and Wigderson used trapdoor functions—functions that are easy to compute but whose inverses are not easy to compute—together with the ideas underlying the Alice/Bob scheme above to show that theorems arising from NP-complete problems have zero-knowledge proofs. A problem is, loosely speaking, in the class NP if it is easy to verify an answer. It is NP-complete if it is at least as hard, in a suitable sense, as any other problem in this class. The famous conjecture that $NP \neq P$ could be viewed, loosely, as saying that discovering proofs is genuinely harder than verifying proofs.

The existence of NP-complete problems is sometimes called Cook's Theorem. The Hamiltonian Circuit problem is an example of an NP-complete problem. Recall that a graph is a collection of vertices and edges joining some pairs of vertices; a Hamiltonian circuit is a tour of all vertices that passes along the edges, visits each vertex exactly once, and returns to the starting vertex. The problem is then: Does a graph G have a Hamiltonian circuit? It is clear that this problem is in NP—it is easy to verify, given a tour, that it is a Hamiltonian circuit. It is considerably harder to prove, as is done in standard computational complexity courses, that this problem is as hard as any other problem in NP—if there is an "easy" general solution then there is an easy general solution to any problem in NP.

Blum's scheme exploits this problem and the ideas underlying the Alice/Bob scheme in an ingenious way. His argument has two steps: a) The assertion "The graph G has a Hamiltonian circuit" has a zero-knowledge proof, and b) Any mathematical theorem within a given "proof system" can be reduced efficiently to a theorem about Hamiltonian paths.

For the first step, suppose that there is a graph visible to both Alice and Bob and that Alice wants to give a zero-knowledge proof that G has a Hamiltonian circuit. Thus, she wants to convince Bob beyond a shadow of a doubt that there is such a circuit without giving Bob the slightest hint about where the circuit is. Presumably G is sufficiently large so that it is well beyond the reach of Bob's computational power to find a tour directly. The following dialogue provides a zero-knowledge proof: First A secretly hides an encoding of the graph. At this point B can ask for one of two things: Either he can ask A to reveal graph (so that he can verify that in fact the hidden graph was G), or he can ask A to verify that the hidden graph has a Hamiltonian circuit. Blum describes a natural way in which to suitably accomplish the encrypting so that an answer to one of these two questions provides no information about the other. This process is repeated k times—A chooses a random encoding, B asks for the key to that coding or for the exhibition of a Hamiltonian circuit in the scrambled graph. Blum proves that if this protocol is followed then the probability that A does not possess a proof if k rounds are completed successfully is 2^{-k} . He also shows that B gets no hint of the circuit (other than its existence) from this protocol, and in fact that this scheme provides a zero-knowledge proof in the technical sense described by Goldwasser, Micali, and Rackoff.

The second step in Blum's argument is a reduction of an arbitrary mathematical theorem (together with an upper bound on the length of some proof in the given formal system) to an assertion that a specific graph has a Hamiltonian circuit. This is similar in style to the general reduction in the proof of Cook's theorem and can be done mechanically (i.e. by an efficient computer program).

The idea of a zero-knowledge interactive proof will undoubtedly recur in a number of other contexts. Fiat and Shamir recently showed that this idea can be combined with earlier cryptographic work of Shamir to give a practical identification scheme. Suppose that a bank wants to encode information on a bank card that would identify customers to branches of the bank. The identification protocol would be interactive (much as one might imagine a computer asking you questions about your password rather than asking you for the password). This scheme was described by Shamir at the International Congress; he showed that the amount of computation and data transmission required are well within the reach of current technology. In addition, even if the user deciphers the contents of the card he or she will not be able to forge a card for someone else; similarly, the bank branch can not impersonate the user by mimicking the answers that the user would give even after numerous identification protocols.

The pace of investigation in complexity and cryptography is rapid. The ideas above will be reworked and occur soon in other schemes. Some of the problems in computational complexity that have obtained their recent importance from cryptography have also been in the air this last summer. It is perhaps surprising to hear that work on the problem of primality testing currently involves the heretofore abstruse realms of abelian varieties and automorphic functions, but in view of the long history of the nourishment that mathematics has provided and received from outside applications, perhaps this is only to be expected.

Joe Buhler teaches at Reed College in Portland, Oregon, and is visiting this year at the Mathematical Sciences Research Institute in Berkeley, California.

Testing Conference (continued from page 1)

The second day of the conference was spent in three concurrent working groups each addressed to one of the following three questions central to the design of the MSEB study on the influence of testing on mathematics education. The questions were:

- What is already known in this area?
- What new knowledge is needed?
- How should a major national study of the impact of testing on mathematics education be designed?

The need to build responsive testing into the national system was discussed—testing that changes as curriculum changes, and that can lead the curriculum when desirable. High on the list of concerns were the negative effects of the use of unidimensional (single-score) tests to assess multidimensional mathematics learning, and the focus of current tests on calculation/manipulation that virtually ignores problem-solving and higher order thinking skills. The conference did not attempt to resolve these specific issues. However, its results will help guide the MSEB efforts over the next 1-2 years in collecting the systematic data needed to support sound recommendations for change.

The MSEB was established in October, 1985, at the urging of the mathematics community, as a major unit of the National Research Council, the operating arm of the National Academy of Sciences. The project on testing is part of an integrated MSEB program for K-12 mathematics, which includes the development of forward-looking curricular frameworks, recommended standards, and significantly enhanced programs of in-service teacher education. For more information about MSEB or its program on testing, contact:

Marcia P. Sward, Executive Director
National Research Council
Mathematical Sciences Education Board
2101 Constitution Avenue, N.W.
Washington, D.C. 20418
(202) 334-3294



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Ronald M. Davis, Northern Virginia Community College.

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People in the News

Mervin E. Muller, professor and chairman of the Department of Computer and Information Science at the Ohio State University, by action of the Board of Trustees has been named the Robert M. Critchfield Professor in Engineering for the next four years. This professorship was endowed by the late Robert M. Critchfield, a graduate of OSU, who was a vice president of General Motors Corporation.

At the National Bureau of Standards, **Dr. Burton H. Colvin**,

Director of the Center for Applied Mathematics, has been appointed Director of Academic Affairs in the Office of the Director. Dr. Francis E. Sullivan will be the new Director of the Center for Applied Mathematics.

Richard I. Resch has been appointed Dean of Science and Technology at the College of Staten Island where he was previously Assistant and then Associate Dean of Faculty.

Calendar

National MAA Meetings

70th Annual Meeting, San Antonio, Texas, January 21-24, 1987.
64th Summer Meeting, Salt Lake City, Utah, August 5-8, 1987.
71st Annual Meeting, Atlanta, Georgia, January 6-9, 1988.
72nd Annual Meeting, Phoenix, Arizona, January 11-14, 1989.
73rd Annual Meeting, Louisville, Kentucky, January 24-27, 1990.

Sectional MAA Meetings

Allegheny Mountain, Gannon University, Erie, Pennsylvania, April 1987.
Illinois, Northern Illinois University, DeKalb, Illinois, April 24-25, 1987.
Indiana, Franklin College, Franklin, Indiana, October 3-4, 1986; Wabash College, Crawfordsville, Indiana, March 28, 1987.
Iowa, University of Northern Iowa, Cedar Falls, Iowa, April 24-25, 1987.
Kansas, Washburn University, Topeka, Kansas, March 27-28, 1987.
Kentucky, University of Louisville, Louisville, Kentucky, April 3-4, 1987.
Louisiana—Mississippi, Mississippi University for Women, Columbus, Mississippi, February 27-28, 1987.
Maryland—D.C.—Virginia, Loyola College, Baltimore, Maryland, November 21-22, 1986.
Metropolitan New York, Borough of Manhattan Community College, New York, New York, May 2, 1987.
Michigan, Michigan State University, East Lansing, Michigan, May 1-2, 1987.
Missouri, Northeast Missouri State University, Kirksville, Missouri, April 3-4, 1987.
Nebraska, Nebraska Wesleyan University, Lincoln, Nebraska, April 10-11, 1987.
New Jersey, Georgian Court College, Lakewood, New Jersey, November 15, 1986.
North Central, University of North Dakota, Grand Forks, North Dakota, October 24-25, 1986.
Northeastern, Worcester Polytechnic Institute, Worcester, Massachusetts, November 21-22, 1986.
Northern California, San Jose State University, San Jose, California, February 28, 1987; Special Meeting, University of Hawaii, Honolulu, Hawaii, March 28, 1987.

Ohio, University of Toledo, Toledo, Ohio, October 24-25, 1986.
Oklahoma—Arkansas, East Central Oklahoma State University, Ada, Oklahoma, March 27-28, 1987.
Pacific Northwest, Pacific Lutheran University, Tacoma, Washington, June 19-20, 1987.
Rocky Mountain, University of Southern Colorado, Pueblo, Colorado, April 24-25, 1987.
Seaway, Mohawk Valley Community College, Utica, New York, November 7-8, 1986.
Southeastern, Armstrong State College, Savannah, Georgia, April 3-4, 1987.
Southern California, California State College at San Bernadino, California, November, 1986.
Southwestern, University of New Mexico, Albuquerque, New Mexico, Spring, 1987.
Texas, Tarleton State University, Stephenville, Texas, April 2-4, 1987.
Wisconsin, University of Wisconsin Center, Sheboygan, Wisconsin, April, 1987.

Other Meetings

November 1986

13-16. **AMATYC National Convention**, Golden Gateway Holiday Inn, San Francisco, California. Contact: Hal Anderson, Department of Mathematics, Santa Rosa Junior College, Santa Rosa, California 95401.

June 1987

24-26. **1987 National Educational Computing Conference**, Temple University, Philadelphia, Pennsylvania. Conference information and registration forms: Frank L. Friedman, General Chair, NECC'87, Computer Activities Bldg, Box JA1, Dept. of Computer and Information Sciences, Temple University, Philadelphia, PA 19122 (215) 787-8450; specifications for submission of original papers: Laurie Scheir.

29–July 3. **ICIAM87**, First International Conference on Industrial and Applied Mathematics, LaVillette, Paris, France. Sponsored by: GAMM, IMA, SIAM, and SMAI. For information write: SIAM, 14th Floor, 117 South 17th Street, Philadelphia, PA 19103-5052, USA.

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