FOCUS

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Reexamining Federal Science Policy

Lisa Thompson

Despite the approaching completion of the 102nd Congress and a presidential term, the federal research establishment has been busy this fall with a number of reexaminations of national science policy. Two in particular have far-reaching potential to change the government's approach to supporting basic science.

U.S. science policy was essentially formulated after World War II by Vannevar Bush. In a tract called *Science—the Endless Frontier*, Bush set forth the rationale for federal support of scientific research and established the basic principles that underlie science policy. These have changed little during the subsequent forty-year postwar period.

As is widely acknowledged, the world has seen many changes since then—the collapse of communism and the rise of the global economy to name but two. It is not surprising that science and technology would be asked to help the nation deal with the challenges posed by these changes, especially with the decline of U.S. industrial competitiveness.

But many believe that existing federal science policy, designed in the 1940's, is not suitable if the nation is to prosper in the "post-Vannevar Bush era," as it is labeled by Frank Press, President of the National Academy of Sciences. Press sees the increasing relevance of basic science to economic and social priorities and calls for more rational procedures to determine the federal R&D agenda.

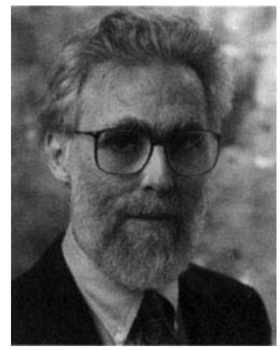
Representative George Brown (D-CA), Chairman of the House Committee on Science, Space, and Technology, also sees a paradox: the challenges the nation faces are accelerating despite its having the most productive and innovative research system in the world. Brown, who has advocated the mobilization of science and technology to address humanity's pressing problems throughout his nearly thirty-year congressional career, believes science and technology policy must be systematically developed in the context of national goals.

House Science Committee to Consider Goal-Oriented Science Policy

Brown is leading the most revolutionary reassessment of federal support for research since Vannevar Bush's. In September, he released a Committee staff report recommending that science policy be more closely linked with national goals. The report questions the validity of long-standing assumptions about federal research and development and suggests a new paradigm for science policy- making in the future. It also cautions that new approaches should be "carefully defined and modular, to avoid throwing out the good with the bad."

*Please see **Federal Policy** on page 2*

Mathematicians to Honor Children's Television Workshop's Joel Schneider



Dr. Joel E. Schneider, JPBM Communications Award recipient

The Joint Policy Board for Mathematics Communications Award will be presented to Dr. Joel E. Schneider on 14 January 1993 in San Antonio, Texas, at a ceremony held in conjunction with the 1993 Joint Mathematics Meetings of the American Mathematical Society and the Mathematical Association of America.

Joel Schneider has been content director for the Children's Television Workshop's ***Square One TV*** since its inception in 1985. The author of numerous books and articles about mathematics and mathematics education, Dr. Schneider is also adjunct professor at Teachers College of Columbia University. He earned his PhD in Mathematics at the University of Oregon.

In announcing the award, JPBM Chairman Richard Herman said, "Joel's work with ***Square One TV*** exemplifies the spirit of the JPBM Commu-

*Please see **Schneider** on page 2*

The Facts About Japanese Mathematics Education

Are Japanese high school graduates better prepared in mathematics than their American counterparts? Or is it more the case that the Japanese school system produces students who can perform well at routine tests involving the regurgitation of facts learned by rote, but are unable to think originally? Both views are heard frequently. But what are the facts? This month FOCUS comes with a special pull-out section in which we reprint in full the 1990 Japanese University Entrance Examination in Mathematics, along with various supporting data.

I suggest you read this report for yourself (additional copies are available from the MAA at a small cost) and form your own conclusion. FOCUS actively solicits responses from MAA members, and plans to publish a representative selection of the letters received in future issues. Write to me, Keith Devlin, FOCUS editor, Department of Mathematics and Computer Science, Colby College, Waterville, Maine 04901.

—Keith Devlin

Federal Policy *from page 1*

Federal support for academic research is based on the premise that basic research, selected by criteria of excellence and performed by individual investigators, indirectly results in societal benefits, and that more high-quality basic research will translate into more societal benefits. The report does not directly dispute this assumption, but points out that it has never been tested, largely because the research system was designed by and for researchers who have no incentive to alter it. Science and technology were given partial credit for the unrivaled economic performance of the U.S. prior to the 1980's, so alternatives to current science policy have never been explored. In today's climate of increasing competition and declining federal budgets, however, carefully designed experiments in policy alternatives are in order.

The report recommends that federal R&D be exploited as a tool for achieving national objectives. Furthermore, research programs, currently evaluated mostly in terms of scientific or technical excellence, need to be measured for progress toward their stated goals by incorporating regular performance assessments into the administration and oversight of federal research programs.

The report calls on the Committee to use its legislative authority over the Office of Science and Technology Policy to transform the agency into a "command center" for the implementation and evaluation of major research decisions. Moreover, the report recommends upgrading the responsibilities of the Federal Coordinating Council for Science, Engineering, and Technology from interagency coordination to the development of a coherent national science policy. These measures would, says the report, "help move science-policy making from the current *ad hoc*, agency-by-agency, OMB-dominated process that exists today, to a more strategic process oriented toward the conduct, goals, and users (not just the performers) of research."

The Committee and its subcommittee on science will begin hearings next year to discuss these proposals and further consider formulation of the goal-oriented science and technology policy envisioned by the staff report.

THE NSF RETHINKS ITS MISSION

Perhaps of most immediate impact on the federal relationship with the mathematical sciences is a reconsideration of the mission of the National Science Foundation by the agency's governing body, the National Science Board. In August, NSF Director Walter Massey issued a white paper describing three options for the agency: reverting to a small agency that supports individual investigators and small groups at universities; continuing both support for academic research and incremental programs that link universities and industries, like the Engineering Research Centers and the Manufacturing Initiative; or adopting an expanded portfolio of programs closely aligned with the users of research, including industry and other government agencies.

Massey believes that the current path of the NSF, represented by the second option, is unstable because the demand for these incremental, industrially-oriented programs—often lumped together under the term, "technology transfer"—will require more resources than NSF can provide without cutting its core research programs. Indeed, congressional appropriators increasingly emphasize these technology transfer-type programs in their instructions to NSF concerning spending allocations.

Massey's preference, grounded in a keen analysis of the political, economic, and scientific environment, is the third option. "By expanding its function, NSF would have the opportunity to build upon its role as the premier supporter of fundamental research while it assumes further responsibility for forging the links between science and technology." The National Science Board, in advance of adopting a long-range strategy for the agency, established a Commission on the Future of the National Science Foundation, which is examining, in Massey's words, "how the NSF can maintain and enhance America's strength in science and engineering research in ways that adequately prepare the nation for the 21st century." The Commission is responsible for considering the views of the scientific community and other parties concerned with the future direction of the NSF.

The Commission's report is due this month. The first opportunity for the research community to gauge its effects could come as early as the FY 1994 budget submission, which will be released in late January or early February. Congress, itself in for some vast changes—perhaps more than 100 new members—will also look closely at the new strategic thrusts of the Foundation. The spending committees will consider not only the FY 1994 budget proposal in terms of the NSF's mission, but could also revisit FY 1993 appropriations. Moreover, the agency must be reauthorized next year. The House Science Committee's efforts to revitalize national science policy should dovetail with its evaluation of the NSF's mission and programs. In fact, Representative Brown is pleased with the strategic planning efforts of NSF, as well as those of the National Institutes of Health. If they are driven by national goals, he says, the plans would be the natural "cornerstones of an evolving research agenda."

The scientific community will still have a voice in the development of principles and policies guiding federal support for research. But we will have to adapt to the new environment in which science policy is made. In short, the onset of the post-Vannevar Bush era could bring unprecedented challenges and opportunities for all concerned with federal support for basic science.

Lisa Thompson *is the Assistant for Governmental Affairs for the Joint Policy Board for Mathematics.*

Schneider *from page 1*

nications Award. There is no doubt that many Americans have an increased interest in and enthusiasm for mathematics as a result of viewing the program. As the creative mathematics genius behind the program, it is fitting Joel Schneider should be so honored."

Square One TV is a half-hour television program seen weekdays on the Public Broadcasting Service. Mathematical topics are drawn from probability, statistics, data representation and analysis, as well as arithmetic and geometry.

CTW developed ***Square One TV*** for home viewing to make mathematics enjoyable, interesting, and exciting for eight- to twelve-year-old children. Its magazine format features "Mathnet," a daily continuing detective serial, original music videos, animation, and comedy sketches.

This is the fourth JPBM Communications Award. Previous awards have been granted to James Gleick, author of *CHAOS*; playwright, Hugh Whitemore, for "*Breaking the Code*"; and Ivars Peterson, author of several books and a science journalist at *Science News* magazine.

The Joint Policy Board for Mathematics is the public policy arm of its three member societies: the American Mathematical Society, the Mathematical Association of America,and the Society for Industrial and Applied Mathematics. The president and executive director of each society, plus three individually appointed representatives, make up its nine-member board.

Square One TV *cast members, top, Larry Cedar, Beverly Mickins; middle (L to R), Cristobal Franco, Priscilla Lopez, Reg E. Cathey; bottom, Cynthia Darlow, Arthur Howard.*

February AAAS Meeting in Boston to Offer Strong Mathematics Program

Warren Page

The 1993 Annual Meeting of the American Association for the Advancement of Science, 11–16 February 1993, will feature many outstanding expository talks by prominent mathematicians. These include the following symposia (three–hour sessions) and invited talks sponsored by Section A (Mathematics) of the AAAS.

- ❑ How Mathematicians Think, organized by Karen V. Parshall and Judith V. Grabiner
- ❑ Operations Research and Mathematics, organized by Carl Harris
- ❑ Randomized Algorithms in Pure Mathematics, organized by Peter Winkler
- ❑ Mathematics of Everyday Language, organized by Keith Devlin
- ❑ Symbolic Computation: Its Impact on Mathematics and Science, organized by Zaven Karian
- ❑ Knots in Math/Physics, organized by Louis H. Kaufman
- ❑ Contemporary Methods of Numerical Computation and Analysis, organized by Douglas Arnold
- ❑ Emergence of Behavior in Coupled Neural Oscillators, organized by Bard Ermentrout
- ❑ Contributions of Mathematics to Industrial Competitiveness, organized by James Glimm and Peter Castro
- ❑ Ethnomathematics, organized by Chandler Davis
- ❑ Interdisciplinary Curricula in Mathematics, Statistics, and Science, organized by Turkan K. Gardenier
- ❑ Frontiers of Science talk on Wavelets, by Ingrid Daubechies
- ❑ Plenary Address, by Vaughn Jones

Section A of the AAAS is also co–sponsoring various symposia that will be of interest to mathematicians and mathematics educators. These include:

- ❑ Statistics and Molecular Biology, organized by Herman Chernoff
- ❑ Statistical, Methodological, and Substantive Aspects of MetaAnalysis, organized by Robert Rosenthal and Jessica Utts
- ❑ Handedness in the Scientific Domain, organized by Kurt Mislow
- ❑ Public Understanding of Environmental Science, organized by Jon Miller
- ❑ The Objectivity Crisis: Rethinking the Role of Science in Society, organized by Daniel Sarewitz and George Brown
- ❑ Adaptive Computation and Artificial Worlds, organized by Rolf Sinclair

The above symposia are only a few of the 150 or so AAAS program offerings in the physical sciences, life sciences, and the social and biological sciences that will broaden the perspectives of students and professionals alike. Indeed, AAAS Annual Meetings are showcases of American science, deserving greater participation by mathematicians. In presenting mathematics to the AAAS Program Committee, I have found the Committee genuinely interested in more symposia on mathematical topics of current interest. The Section A Committee is looking for organizers and speakers who can present substantial new material in understandable ways.

The task is not easy, but the outstanding success of the mathematics symposia at last year's AAAS Annual Meeting in Chicago proved that effort and inspiration can accomplish wonders. That meeting's mathematics program showed that first-rate mathematical researchers can also effectively reach a broad scientific audience.

We in Section A of the AAAS know that the increasing representation and participation of mathematicians at AAAS Annual Meetings are important means for deepening public awareness and appreciation of the manifold ways that mathematics contributes to science and society. I need and welcome your suggestions for symposia topics and individuals who might be able to organize them.

I hope that you will have the opportunity to attend some of this year's exciting symposia in Boston. For details see the 25 September issue of *Science*. I invite you to attend our Section A Committee Meeting, 5:30p.m.–7:00 p.m. Saturday 13 February, Liberty E room at the Sheraton Boston Hotel. The committee meeting is open to all who wish to stimulate interest and activities of the mathematical sciences within the AAAS. Please send to me, and encourage your colleagues to send me, symposia proposals for future AAAS meetings.

***Warren Page** is Chair of the MAA Notes Editorial Board, a past Second Vice President of the MAA, and Secretary of Section A of the AAAS.*

MAA Elections

Call for Nominations

The Nominating Committee for 1993 welcomes nominations from the membership for the following officers of the Mathematical Association of America: President, First Vice President, and Second Vice President. The new officers will be elected by a mail ballot circulated to the entire membership in the spring.

The elected officers' terms will begin at the end of the Business Meeting at the January 1994 meeting in Cincinnati. Nominations should be sent to the Chair of the Nominating Committee, Kenneth A. Ross, Department of Mathematics, University of Oregon, Eugene, OR 97403 prior to 8 JANUARY 1993. Other members of the Nominating Committee are Lida K. Barrett, John D. Neff, Martha J. Siegel, and Alan C. Tucker.

Research in Collegiate Mathematics Education — A Call for Papers

Following the announcement (FOCUS, October 1992) that the Conference Board of Mathematical Sciences will publish an annual volume of papers on Research in Undergraduate Mathematics Education under the aegis of the MAA committee of that name, the editors are calling for papers to be submitted. The following editorial statement should provide authors with all necessary information.

The editors suggest that, to be given full consideration for the first volume, manuscripts should be submitted by 1 March 1993. Papers submitted after that date are more likely to be considered for the second volume.

Editorial Policy

The papers published in these volumes will serve both pure and applied purposes, contributing to the field of research in undergraduate mathematics education and informing the direct improvement of undergraduate mathematics instruction. The dual purposes imply dual but overlapping audiences and articles will vary in their relationships to these purposes. The best papers, however, will interest both audiences and serve both purposes.

Content

We invite papers reporting on research that addresses any and all aspects of undergraduate mathematics education. Research may focus on learning within particular mathematical domains. It may be concerned with more general cognitive processes such as problem solving, skill acquisition, conceptual development, mathematical creativity, cognitive styles, etc. Research reports may deal with issues associated with variations in teaching methods, classroom or laboratory contexts, or discourse patterns. More broadly, research may be concerned with institutional arrangements intended to support learning and teaching, e.g. curriculum design, assessment practices or strategies for faculty development.

Method

We expect and encourage a broad range of research methods ranging from traditional, statistically oriented studies of populations, or even surveys, to close studies of individuals, both short and long term. Empirical studies may well be supplemented by historical, ethnographic, or theoretical analyses focusing directly on the educational matter at hand. Theoretical analyses may illuminate or otherwise organize empirically based work by the author or that of others, or perhaps give specific direction to future work. In all cases, we expect that published work will acknowledge and build upon that of others—not necessarily to agree with or accept others' work, but to take that work into account as part of the process of building the integrated body of reliable knowledge, perspective, and method that constitutes the field of research in undergraduate mathematics education.

Review Procedures

All papers, including invited submissions, will be evaluated by a minimum of three referees, one of whom will be a Volume editor. Papers will be judged on the basis of their originality, intellectual quality, readability by a diverse audience, and the extent to which they serve the pure and applied purposes identified earlier.

Submissions

Papers of any reasonable length will be considered, but the likelihood of acceptance will be smaller for very large manuscripts.

Five copies of each manuscript should be submitted. Manuscripts should be typed double–space, with bibliographies done in the style used by the American Mathematical Society and Mathematical Association of America journals. Manuscripts should eventually be prepared using either AMS–TeX (amsppt) or AMS–LaTex (amsart). The macro packages are available through email without charge.

Correspondence

Manuscripts and editorial correspondence should be sent to one of the three editors:

Ed Dubinsky
Purdue University
1395 Mathematical Science Building
W. Lafayette, IN 47907-1395
(bbf@j.cc.purdue.edu)

James Kaput
Department of Mathematics
University of Massachusetts, Dartmouth
North Dartmouth, MA 02747
(JKAPUT@umassd.edu)

Alan Schoenfeld
School of Education
University of California
Berkeley, CA 94720
(alans@violet.berkeley.edu)

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Editor: Keith J. Devlin, Colby College

Associate Editors: Donald J. Albers, MAA Associate Executive Director and Director of Publications and Programs
Barbara Trader Faires, Westminster College

Production Specialist: Amy E. Stephenson, MAA

Chair of the MAA Newsletter Editorial Committee: Joseph A. Gallian, University of Minnesota at Duluth

Subscribers should address letters to the editor: Keith Devlin, Department of Mathematics and Computer Science, Colby College, Waterville, Maine 04901; telephone and fax: (207) 872-3257; email: kjdevlin@colby.edu.

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Joint AMS - MAA Meetings Update

San Antonio, Texas 13 – 16 January 1993

Changes, Additions, and Corrections

The **AMS - MAA Special Session** on Environmental Modeling has been canceled.

New MAA Panel Discussion on Mathematical Research for Undergraduate Students from 1:00 p.m. to 2:20 p.m. on Saturday 16 January 1993. The discussion is sponsored by the Mathematical and Computer Sciences Division, Council on Undergraduate Research, and the panelists will be: David L. Housman, Drew University; Robby Robson, Oregon State University; Brigitte Servatius, Worcester Institute of Technology; and Gary J. Sherman, Rose-Hulman Institute of Technology. The moderator will be John Greever, Harvey Mudd College.

New MAA Panel Discussion on ICME-7 from 1:00 p.m. to 2:15 p.m. on Friday 15 January 1993, organized by Betty K. Lichtenberg.

New MAA Panel Discussion on Precalculus Reform from 9:30 a.m. to 10:55 a.m. on Friday 15 January 1993. The moderator will be William F. Lucas, Claremont Graduate School, and the panelists will be: David C. Arney, United States Military Academy; Franklin D. Demana, Ohio State University; Sheldon P. Gordon, Suffolk County Community College; Daniel J. Teague, North Carolina School of Science and Mathematics.

Minicourse #5B was listed incorrectly in the October FOCUS. Minicourse #5B is "Using Supercalculators to Enhance Instruction and Learning in Linear Algebra," organized by Donald R. LaTorre, Clemson University.

Minicourse #12 "Bringing Calculus to Life" John K. Williams, University of Hartford is co-organizer.

New MAA Poster Session on Laboratory Approaches in Undergraduate Mathematics from 8:00 p.m. to 10:00 p.m. on Thursday 15 January 1993. Organized by James R.C. Leitzel, University of Nebraska, Lincoln, and Arnold Ostebee, St. Olaf College.

New Open Meeting on MAA Strategic Planning, from 8:00 p.m. to 9:00 p.m. on Thursday 15 January 1993. The facilitator will be Thomas W. Tucker, Colgate University.

Photo courtesy of the San Antonio Convention & Visitors Bureau

The San Antonio Zoo, home to over 2,500 animals, including the rare snow leopards, golden lion tamarins, giant armadillos, and whooping cranes.

Events Added to Student Program at San Antonio Meetings

There will be a special presentation titled "*The Art of Mental Calculation*" given by Authur T. Benjamin, Harvey Mudd College, 2:15 p.m. to 3:15 p.m. on Thursday 14 January 1993. Benjamin has demonstrated and explained his rapid mental calculation techniques throughout the world. The demonstration will be given in Salons D, E, and F of the Marriott Riverwalk Hotel following the Career Fair which takes place from noon until 2:00 p.m. at the Marriott.

The MAA Committee on Student Chapters will sponsor two workshops for students. Workshop A, "*Calculus Through Experimentation*" by Herbert Bailey, Rose–Hulman Institute of Technology, will be offered on Friday 15 January from 1:00 p.m. to 2:55 p.m. and repeated as Workshop B on Saturday 16 January from 9:00 a.m. to 10:55 a.m. The workshops will be "hands–on" but will not involve computers. There is no charge, but space is limited and pre-registration is required. To enroll in either workshop, write to Jane Heckler, Mathematical Association of America, 1529 Eighteenth Street NW, Washington, DC 20036–1385.

Other special events planned for students include the Student Lecture "*Touring by Torus*"; Joseph A. Gallian, University of Minnesota-Duluth at 7:30 p.m. on Friday 15 January. This lecture will be followed by a "make-your-own sundae" party.

All students are encouraged to look in on the Student Hospitality Center that will be open throughout the meetings. The Hospitality Center is located in the VIP and Rehearsal Rooms at the Convention Center.

Papers in the Student Chapter session, Saturday morning, 16 January 8:00-10:55. No abstracts, but the presenters will circulate their own list of abstracts. They are:

8:00 Richard L. Poss, St. Norbert College, WI, "Organizing a student-run math competition"

8:20 Donald G. Beane, The College of Wooster, OH, "Wooster reaches out with 'infinity' "

8:40 Donald Marxen, Loras College, IA, "Mathematics service programs"

9:00 Paul Patterson, Saint Louis University, MO, "A gathering of the mathematical community"

9:20 Catherine A. Gorini, Maharishi International University, IA ,"Student-organized chapter activities"

9:40 Karen J. Schroeder, Bentley College, MA ,"Student chapters: a dual perspective"

10:00 Deborah A. Frantz, Kutztown University, PA, "Careers in mathematics student conference"

10:20 Judith Palagallo, The University of Akron, OH, "Activities of the Ohio Section"

10:40 Ronald F. Barnes, University of Houston-Downtown, TX, "Student activities in the Texas Section of MAA"

1993 Residential Summer Institutes for Mathematically Talented Undergraduates

UNIVERSITY OF CALIFORNIA AT BERKELEY (19 JUNE – 31 JULY 1993)

The fifth annual Summer Mathematics Institute (SMI) at UC Berkeley seeks applicants from African-American, Hispanic-American, and Native-American undergraduate men and women who are considering research careers in mathematics and related fields. Approximately 30 students will receive room and board, a $2,000 stipend, and the cost of transportation to and from Berkeley. The SMI is a cooperative project of the Mathematics departments at UC Berkeley and the University of Texas at Austin. Program organizers are Professor Uri Treisman, University of Texas at Austin and Professor Leon Henkin, UC Berkeley.

MILLS COLLEGE (19 JUNE – 31 JULY 1993)

The third annual intensive mathematics program at Mills College is seeking applications from undergraduate women of all ethnic groups who are considering research careers in mathematics and related fields. Twenty students will be admitted to the 1993 program; each will receive room and board, a $2,000 stipend, and the cost of transportation to and from Oakland. Program organizers are Lenore Blum, International Computer Science Institute; Steven Givant, Mills College; Leon Henkin, UC Berkeley; and Deborah Nolan, UC Berkeley.

The Institutes are supported by a grant from the National Science Foundation. Faculty members are asked to seek out candidates for the programs and encourage them to apply. All applicants must have completed *with distinction* at least one year of college mathematics beyond freshman calculus by June 1993. In addition, applicants to the Mills Program must have completed one course that involves extensive exposure to discovering and writing proofs.

INSTITUTE DESCRIPTION

Participants will explore in depth two areas of mathematics. Part of this exploration will take place in seminars consisting of approximately 12 students each and taught by active research mathematicians. Seminar students will be encouraged to tackle challenging problems individually, in small groups, and in consultation with graduate student mentors. In addition, there will be weekly colloquia designed to provide participants with a broad view of current work in mathematics. Lastly, students will participate in informal workshops that will (1) assist them in making informed decisions about graduate school, (2) give them current information about fellowships and financial aid opportunities to support their graduate studies, and (3) make them aware of career opportunities for mathematicians.

Application deadline for both programs is 12 February 1993. Further information and application forms for the Institute at UC Berkeley can be obtained by calling Olga Alvarez at (512) 471–3285, or by writing to the Office of Special Projects, College of Natural Sciences, University of Texas, W.C. Hogg Building #204, Austin, TX 78712. Further information and application forms for the Mills Program can be obtained by calling Kathy Guarnieri at (510) 430–2226 or by writing to Summer Mathematics Institute, c/o Mills College, Oakland, CA 94613.

World Federation of National Mathematics Competitions

PRESENTATIONS OF THE HILBERT AND ERDOS AWARDS

In August 1992, six mathematicians and mathematics educators were awarded the International David Hilbert Awards and the National Paul Erdos Awards by the World Federation of National Mathematics Competitions. The three recipients of the Hilbert Award are Martin Gardner, Murray Klamkin, and Marcin Kuczma. The three recipients of the Paul Erdos Award are Luis Davidson, Nikolay Konstantinov, and John Webb.

The World Federation of National Mathematics Competitions was formed in 1984 at the Fifth International Congress of Mathematics Education in Adelaide, Australia. One of its aims is to raise the public awareness of the role that mathematics challenges can play in the motivation and enjoyment of learning mathematics. The David Hilbert Award was created to help the Federation honor those mathematicians who have significantly contributed to the development of mathematical challenges at the international level—contributions which have given great stimulus and motivation in the enrichment of mathematics learning.

THE HILBERT AWARDS

Martin Gardner is regarded by the scientific community and the community at large as the master communicator of mathematics. His books and articles have over the years been read by more students of mathematics than any other writer in history. His clear expositions of mathematical concepts and ideas have enabled the community at large to share the beauty and excitement of mathematics. The inscription on the Award reads "for his outstanding series of books and articles which have made mathematical recreations exciting and challenging, and yet at the same time accessible to both the scientific community and the public community in general."

Professor Murray Klamkin, University of Alberta, Canada was selected for his numerous stimulating challenges and articles on challenges and for his books on the United States of America Mathematical Olympiads and the International Mathematical Olympiads. Professor Klamkin studied chemical engineering and physics in college. For many years he worked for the Ford Motor Company. According to Stanley Rabinowitz, editor of *Index to Mathematical Problems*, Murray Klamkin is the most prolific problemist of our time.

Dr. Marcin Emil Kuczma, University of Warsaw, Poland has been involved in mathematical competitions since 1975, when he joined the Polish Mathematical Olympiad Committee. As a mathematician, he works in the area of analysis (measure theory), but his problems and solutions cover a very wide range. He has been a member of the Polish delegation to the IMO, the delegation leader, a member of the Jury of the Austrian–Polish Mathematics Competition, and a chief trainer of the Polish team for the IMO. He has run the Club-44 Contest in the journal *Delta* since 1987. On the international level, he helped organize the 1986 International Mathematical Olympiad in Warsaw.

Pictured from left to right: Dr. Luis Davidson, Cuba; Professor John Webb, South Africa; Professor Miguel de Guzmán, President, International Commission on Mathematical Instruction; Professor Murray Klamkin, University of Alberta; and Dr. Marcin Kuczma, University of Warsaw, Poland.

THE ERDOS AWARDS

Dr. Luis Davidson, University of Havana, Cuba graduated from the University of Havana in 1944. In 1963 he was named National Inspector of Education in Cuba. The national mathematics competition he founded eventually became the Annual Mathematics Competition in Cuba, which enabled Cuba to become the first country (in 1971) from North or South America to participate in the International Mathematical Olympiad. In 1987 Cuba hosted the IMO and Dr. Davidson was the chief organizer. Dr. Davidson is currently Vice President of the Cuban Mathematical Association and Editor of the Cuban Mathematical Society *Bulletin*.

Dr. Nikolay Konstantinov, Moscow, Russia founded the Tournament of Towns in 1980, and has nurtured it to its current status as one of the premier mathematical competitions in the world. Dr. Konstantinov is the President of the Coordinating Council of Independent Universities of Moscow, the first Pro–Dean of the Higher Mathematics College, and President of the International Tournaments of Towns. From 1968 until 1980 he was a member of the National Mathematical Olympiad of the USSR.

Dr. John Webb is a graduate of the University of Cape Town and of Cambridge University, and he has been on the faculty at the University of Cape Town since 1966. He founded the *Mathematical Digest* in 1971, and has served as editor ever since. Since 1987 he has directed the University of Cape Town Mathematics Competition. In 1992, he led South Africa's first-ever entry in the IMO.

Visiting Mathematicians Sought for MAA's Washington, DC Headquarters

Marcia P. Sward, Executive Director

If you have a sabbatical coming up or if you are about to retire, and if you are interested in national mathematics issues, think about spending a semester or a year at MAA Headquarters as a *Visiting Mathematician*. A summer in Washington is also possible.

If you think you might be interested, please call me at (202) 387-5200 or write and tell me about your background and interests: The Mathematical Association of America, 1529 Eighteenth Street Northwest, Washington, DC 20036–1385. The MAA Staff and Services Committee will review all applications and make appointments on the basis of (1) the needs of the office, and (2) the interests and skills of the applicant.

Networks in FOCUS

List Servers and News Groups

by Judy Smith

This article is reprinted, with permission, from Penn Printout, *published by the University of Pennsylvania, May 1991, pp.4-6. Judy Smith is an Information Analyst for the Office of Data Administration and Information Resource Planning. Some minor changes have been made to make the article less specific to the University of Pennsylvania computer system. The article is aimed at readers whose institutions already have Internet access.*

For many academics, electronic mail is the primary function of the Internet, the international "network of networks" of which your own campus network may be a part. But the Internet also supports a variety of other services. This article is an introduction to "list servers" and "news groups," the discussion groups available on BITNET and Usenet, two networks to which the Internet is connected. The first part of this article contains an overview of discussion groups; the next two sections describe how to access the information you need in order to begin participating in discussion groups; and the final section describes why you might select the discussion groups available on one network over those available on the other network.

DISCUSSION GROUPS

Most people are familiar with the traditional discussion groups that facilitate collaborative work. Now imagine such a group without the constraints of size, space, and time: hundreds of users from around the world, participating at their own pace, whenever and from wherever they prefer. Imagine a large number of these participants talking simultaneously, without chaos erupting, and you'll begin to understand what computer-mediated discussion groups are like. The list below, a partial listing of groups formed during March on BITNET, gives just a taste of the variety of topics available.

GROUP@NODE	DESCRIPTION
Assess@uukcc	Assessment
DTP@yalevm	Desktop Publishing
FedTax-L@shsu	Federal Taxation and Acct'ng.
InGraFx@psuvm	Information Graphics
Litera-L@tecmtyvm	Spanish Literature
MedStu-L@unmvm	Medical Students
Ncaa1991@indycms	NCAA Basketball
Screen-L@ua1vm	Film & Television

These discussion groups serve a potpourri of purposes: job postings, conference announcements, and calls for papers often appear along with ongoing discussion threads. Many groups prove to be useful training grounds for neophytes, who may sit on the sidelines and "listen" or who may join in with comments and questions that draw the responses of experts in the field. Other groups restrict participation to those with particular areas or levels of expertise.

Three documents, totaling fewer than one hundred pages, provide directories of most of the discussion groups accessible through the networks: BITNET's "Listserver Lists" and Usenet's "Lists of Active Newsgroups" and "Alternative Newsgroup Hierarchies." What becomes immediately apparent when you start browsing these directories is the variety, breadth, and depth of topics related to computing—the evolutionary result of both heavy utilization and technical savvy. But this dominance by computing, scientific, and engineering fields is slowly being displaced by the growth of discussion groups in social sciences, humanities, business, and the professions. Network use is increasing because technical barriers are becoming less problematic, because more people within the academic community have access to the required technology, and because interest in these collaborative learning environments continues to grow as a result of the number of successful experiments in the medium.

Several other features of discussion groups become apparent as you continue to browse the topic lists. First, you'll notice that some groups are "moderated" or "peered." This means that all submissions to the group are reviewed by someone responsible for keeping the group focused and preventing inappropriate use of the group. Most groups, however, are not moderated; all submissions go immediately to all group members without review. Second, some groups are not really discussion groups at all, but electronic digests, electronic news feeds, and electronic journals. Similar in concept to magazines and books, although often more timely, they provide access to more formal information related to a field of interest. Finally, especially in Usenet, many groups do not welcome discussion; these groups tend to focus on distribution of public domain software, graphics, maps, original poetry, literature,etc. Such groups are often paired with another group that does welcome discussion — the names of the paired groups are often identical except that a "d" is appended to the group name that allows discussion.

LIST SERVERS

Discussion groups are known as list servers on BITNET, the worldwide academic network, which offers discussion groups as one of its services. In order to participate in BITNET discussion groups you will need an electronic mail account and a basic understanding of email addressing.

Perhaps the best way to get started using BITNET discussion groups is to send email requesting information from BITNET's Network Information Center. To request information send mail to LISTSERV@BITNIC (you may have to consult your campus computer center to find out how to translate this and other email addresses in this section to allow for different mail systems) with the following three lines of text:

help

list global

get bitnet userhelp

The first line is a command requesting a one-page document of the most commonly used list server commands (e.g., **list** and **get**). The second command requests a 36-page directory of discussion groups to which you may subscribe. The final command requests an 18-page introduction to BITNET that also directs you to other useful online documentation sources.

To subscribe to any of the discussion groups listed in the directory, send mail to the appropriate list server described in the directory. For example, to subscribe to the new list on information graphics maintained at Portland State University, send email to LISTSERV@PSUVM containing the line:

sub InGraFx FirstName LastName

Networks in FOCUS

You'll receive an automatic message confirming your subscription and will shortly begin to receive messages from the discussion group. To send a message that will be distributed to all InGraFx subscribers, send mail to InGraFx@PSUVM (not to LISTSERV@PSUVM).

If you find the list is not of great interest, you can remove your name from the list by sending mail to LISTSERV@PSUVM containing the line:

signoff InGraFx

When replying to a message received from a list, note carefully which address your local mail software places in the To: field—depending on the list and on your software, your reply might go just to the original sender or to the entire list.

The most common error that new participants make is sending subscription or resignation requests to the discussion group address instead of the list server address. The list-server address will be in the form Listserv@Node (Listserv@PSUVM in the example above) and the discussion-group address will be in the form Discussion Group@Node (InGraFx@PSUVM in the example).

NEWS GROUPS

Discussion groups are known as news groups on Usenet, a worldwide cooperative network unique in that discussion groups are the only service provided. Your institution will most likely maintain a centralized database of news-group discussions on a central file-server. Many schools provide students, faculty, and staff access to the "client" software required to read the news groups available on the central server.

The best way to become familiar with Usenet is to read the 17 articles posted in the news group **news.announce.newusers**. These include the two directory documents referenced earlier in this article, as well as Usenet rules, Usenet primer, Usenet etiquette, and answers to frequently asked questions. After reading these postings, you'll be prepared to begin monitoring and participating in Usenet news groups.

Usenet discussion groups are much more highly structured than BITNET discussion groups. There are seven top-level hierarchies: computer professionals and hobbyists, established sciences, social issues and socializing, debate-oriented groups, the Usenet news network, recreation, and groups that don't fit elsewhere. In addition, your system may carry a variety of groups that are not subject to Usenet rules: alternative news groups, biologists, a subset of BITNET groups, business products, commercial news services, electrical and electronics engineers, and public access systems.

LIST SERVERS VS. NEWS GROUPS

Discussion-group participants often argue the merits of their preferred discussion environment—electronic mail (BITNET) versus news reader software (Usenet). For the most part, these are matters of personal taste. Nevertheless, there are clear differences between the two environments. The immediacy of receiving discussion group postings mixed in with your "regular" electronic mail is a very different experience from that offered by firing up your favorite news reader software and zipping through any number of the 1,000 groups available centrally.

Many academics may find that they have little chance to explore both these contrasting environments. Far more people have access to electronic mail than have access to news reader software. If you are among the fortunate and are able to explore both environments, keep in mind that news groups have one clear advantage over list servers: News groups are more efficient with respect to disk utilization; since only one copy of a posting is sent to the central University server, the automatic proliferation of the same posting to multiple email accounts is avoided.

If you do have a choice between using BITNET or Usenet, try to use Usenet whenever possible, but keep in mind that the disk-utilization problem is clearly outweighed by the benefits of participation.

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The Plugged–In Newton

A new nationwide electronic bulletin board system for science teachers and students has been started by the U.S. Department of Energy's Argonne National Laboratory.

Students and teachers can call and use their computers to ask science questions, share teaching tips, trade classroom materials, hold or participate in conferences, or just chat on-line.

Called "NEWTON," the bulletin board is open, free to anyone who teaches or studies science, computer science, mathematics, or technology at any level.

Services for teachers on NEWTON include ideas for classroom demonstrations, activities and field trips; on-line conferences with teachers and scientists; calendars of conferences, lectures, symposia, workshops, and other professional events for science teachers; electronic communication with other educational networks; and several Argonne publications on science, technology, and education.

Services for students and teachers include "Ask a Scientist," where callers can leave questions to be answered by a scientist as part of a growing collection of questions and answers everyone can read; discussion of hobbies and other special interests; local and worldwide electronic mail over Internet; electronic exchange of computer files and software; and news about Argonne's educational and scientific programs.

The only equipment needed to use NEWTON are a telephone, a computer, a modem, and communications software to run the modem.

Access to NEWTON is by phone: (708) 252–8241. NEWTON can also be reached over Internet, a collection of computer networks, at the address "newton.dep.anl.gov" or "130.202.92.50".

Argonne's educational program involves thousands of science students and faculty each year.

With more than 200 different research programs in basic and applied science, Argonne is one of the nation's largest federally funded scientific laboratories. Argonne National Laboratory is operated by the University of Chicago for the U.S. Department of Energy.

Networks in FOCUS

Telnet: Seeing the World from Your Desktop

Valerie Glauser

This article is reprinted, with permission, from Penn Printout, *published by the University of Pennsylvania, April 1991, pp.8-9. Valerie Glauser is a senior technical writer for DCCS/UMIS Publications. Some minor changes have been made to make the article less specific to the University of Pennsylvania computer system. The article is aimed at readers whose institutions already have Internet access.*

As awareness of computer networking has spread at colleges and universities, you, the wary explorer, may have tentatively foraged around your campus network to find some of the services that are available. You may have heard more technologically adventurous friends speak about the wealth of databases, shareware, and interest group discussions available "for free" on the Internet, that amorphous network of networks of which your campus network is a part.

Now your problem is how to get at these Internet resources. Short of tethering your friend Joe Networkjock to a personal computer and forcing him to type everything he knows about networking into a file you can save, you face a "Catch-22." Virtually all the information about the locations and directions for these resources is on-line.

In the last couple of years, however, several documents have been written to provide information about resources that are publicly available to those with Internet access, and about how to reach them. This article focuses on one such document, the Internet Resource Guide, and the skills and equipment required to use the resources documented in it.

We'll begin with a brief overview of the Internet and its basic services, followed by examples of logon sessions from your campus system to sample Internet services. One caveat: Because the Internet is like a highway with few rest stops, road signs, or maps, it is important not only that you know how to drive the vehicle you're in (your desktop device), but that you know something about the inner workings of it (the operating system and software) and something akin to the location of the North Star or Orion's Belt to guide you in the right direction. This article assumes that you are already familiar with your desktop computer or terminal and have used communications software to connect to your campus mainframe system. For training information on these topics, contact your local Computing Center.

INTERNET OVERVIEW

The Internet is a worldwide internetwork of many computer networks. While there are hundreds of different types of computers that can connect to the Internet, they all have one common denominator: the TCP/IP suite of communications protocols that enables dissimilar computers to communicate in specific ways. Early Internet developers found that there were three important tools of communication that had to work across various types of computers:

-A way to log into colleagues' remotely located host computers

-A way to store and forward messages to individuals and groups

-A way to copy files quickly and reliably from one location to another

The TCP/IP protocol suite fills these three needs by providing the Telnet remote login protocol, the electronic mail protocol (SMTP), and the File Transfer Protocol (FTP) method of fast file transfer. Your local computing network, as a part of the Internet, will provide the technology to deliver all these services.

TELNET: ONLINE RESOURCE SHARING

The Telnet protocol enables you to log in to an Internet-connected remote host computer for live or "real time" interaction. A "remote" location could be across the hall, across the country, or across the ocean. Each computer is identified by a numerical Internet Protocol (IP) address. For example, all IP addresses at Penn begin with either 128.91 or 1309.91. Each also has an alphabetical name that can be used interchangeably with its assigned IP number. For example, Penn's Online Directory service is accessed through the address which is upenn.edu. It can also be accessed through the numerical IP address 128.91.154.1.

While most Internet host computers require individual user IDs and passwords to gain access to them, a number of Internet-connected institutions provide information databases that any member of the Internet community can query using public login addresses. Such databases include library catalogs, such as MELVYL, the University of California's and California State University's online library catalog; discipline-specific information, such as the Dartmouth Dante database, where each reference is in its original language; and campus-wide information services, such as Cornell University's CUINFO. Because each service is located on a different or different kind of host computer, each has its own set of navigational commands, capabilities, and help screens, which sometimes require trial and error to master. However, these are public facilities designed so that you can't inadvertently do any harm to the data.

The Internet Resource Guide, updated regularly, provides listings of services available on the Internet. Each listing provides a U.S. mail address, an electronic mail address and telephone number, a description of the service or services, instructions for accessing them on the Internet, and eligibility requirements. Some services limit their audiences to individuals in related disciplines. Others require only that you obtain an account, with or without a fee, while many are available to anyone with Internet access.

WHERE DO I START?

Regardless of where the remote host computer is located, all you need is access to your local campus mainframe. At most installations, to connect to a computer elsewhere, you would type the following at the prompt:

telnet <hostname.subdomain.domain><RETURN>

For example, to connect to the University of California and California State Library Catalog, type:

telnet melvyl.ucop.edu <RETURN>

To connect to CUINFO, Cornell University's online public information service, type:

telnet cornellc.cit.cornell.edu 300 <RETURN>

Some services require that you enter a public password, which is specified in the directions to access the service. Others require no password, and either immediately display the service's main menu or require one or two other steps, such as identifying the terminal type, before displaying the main menu. From then on, you're on your own. The help screens, online directions, and navigational prompts should help you discover what your next options are. They should also tell you how to logoff of the service when you have completed your search. If those logoff directions do not work, enter the following key sequence:

-Type <BREAK>

-Type kill 1 <RETURN>

Here we have just scratched the surface of what is available through the Internet Resource Guide. Delving into it can be your passport to the world of networking beyond your campus network. Happy trails.

ATLAST, An NSF–ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools

ATLAST 1993 Linear Algebra Workshops

ATLAST is an NSF–ILAS Project to Augment the Teaching of Linear Algebra through the use of Software Tools. The project will offer five faculty workshops during the summer of 1993 on the use of software in teaching linear algebra. Workshop participants will learn about existing commercial linear algebra software packages and will be trained in the use of the MATLAB software package. Attendees will learn how to effectively incorporate computer exercises and laboratories into undergraduate linear algebra courses.

Participants will learn to design computing exercises at a level suitable for assigning to an undergraduate linear algebra class. These exercises will be class–tested during the school year following the workshop and then submitted to the project director for inclusion in an edited manual which will be distributed to the workshop attendees. A selection of these exercises will be included in an ATLAST Project Book. This book will be published by one of the mathematics societies with the provision that its contents will be public domain. Participants' contributions will be acknowledged in both the manual and the Project Book.

The ATLAST Project provides room and board for participants attending the workshops. In addition, participants will receive a $200 stipend for their submitted exercises.

The ATLAST project was conceived by the Education Committee of the International Linear Algebra Society(ILAS) and is funded through the National Science Foundation Undergraduate Faculty Enhancement Program. Steven J. Leon of the ILAS Education Committee is serving as the ATLAST Project Director and the Assistant Director is Richard E. Faulkenberry. Both are in the Department of Mathematics at the University of Massachusetts Dartmouth.

This is the second year of ATLAST workshops. The five workshops offered during the summer of 1992 were a rousing success and we are confident that the 1993 workshops will be even better!

All teachers of undergraduate linear algebra courses at colleges or universities in the U.S. are invited to apply for ATLAST workshops. The deadline for applications is 12 March 1993. Late applications will be accepted on a space–available basis. Each workshop will be limited to thirty participants. A screening committee will review applications and notify applicants of its decisions by the beginning of April.

For application forms or further information about the ATLAST Project contact: Richard Faulkenberry, ATLAST Project Assistant Director, Department of Mathematics, University of Massachusetts Dartmouth, North Dartmouth, MA 02747 (508) 999–8928, FAX (508)999–8901 , email atlast@umassd.edu.

ATLAST 1993 Linear Algebra Workshops Sites, Dates, and Presenters

- **Michigan State University, East Lansing, Michigan**
  17–19 June 1993
  Dr. Steven J. Leon, UMass Dartmouth
- **Los Angeles Pierce College, Woodland Hills, California**
  24–26 June 1993
  Dr. Jane Day, San Jose State University
- **University of Houston–Downtown, Houston, Texas**
  8–10 July 1993
  Dr. Eugene Herman, Grinnell College
- **Georgia State University, Atlanta, Georgia**
  15–17 June 1993
  Dr. Kermit Sigmon, University of Florida
- **University of Maryland, College Park, Maryland**
  22–24 July 1993
  Dr. David Hill, Temple University

Consortium for Ordinary Differential Equations Announces Workshops and Newsletter

The Consortium for Ordinary Differential Equations was founded in 1990 by a group of faculty from six colleges and universities who design and use computer experiments in their teaching of ordinary differential equations. The benefit of NSF support allows the consortium to run summer faculty workshops and publish a newsletter.

Last summer's workshops took place at Cornell University and Harvey Mudd College. Approximately 35 college and university faculty participated in each of these five-day workshops. Workshop participants shared their experiences, exchanged ideas, examined a variety of software packages and text materials, and worked together to design and produce new course materials (projects, demonstrations, etc.).

Similar workshops will be held at St. Olaf College, 20–25 June 1993 and Washington State University, 12–18 June 1993. Rensselaer Polytechnic Institute and West Valley College will host workshops in 1994. Participants in these workshops will receive a small stipend and support for room and board costs. For more information about the 1993 workshops, please contact Professor Arnold Ostebee, Mathematics Department, St. Olaf College, Northfield, MN 55057 (email: ostebee@stolaf.edu) or Professor Michael Kallaher, Department of Pure and Applied Mathematics, Washington State University, Pullman, WA 99164 (email: kalleher@wsumath.bitnet).

The first issue of the consortium's quarterly newsletter, CODEE, was published in October 1992. The specific purpose of the newsletter is to share and facilitate the use of interactive computer experiments in courses involving ordinary differential equations. The fall issue of CODEE included reports on last summer's workshops, software reviews, and several articles. Anyone interested in receiving the newsletter regularly may send a subscription request to: CODEE, Math Department, HMC, Claremont, CA 91711 (email: codee@jarthur.claremont.edu); subscriptions to the newsletter are free.

FOCUS EDITORIAL

Dean Pastaway walked through the gate and was surprised to come face to face with the devil. The realization came to him in a flash: obviously he was paying the price for that time he had overturned the Mathematics Department's recommendation to tenure young Wilkins. Still, it did seem a bit harsh to have one's entire future rest on one event, though, now that he thought about it, Pastaway noted the irony in the long term effect his tenure decision had had upon Wilkins' entire future. But that was for a lifetime; what he was facing was for eternity.

"Well, it was not quite as simple as that," the devil replied when Pastaway questioned the decision that had apparently been made following that last, unfortunate incident with the chicken bone a few hours earlier. "You see, Hell University is in need of a new dean, and you were the only one in the market at the time, as it were."

"Hell University? I didn't know Hell had a university," Pastaway retorted.

"Not many people do," the devil replied. "We don't advertise, you see." Pastaway was unsure whether or not this was meant as a joke, but before he could decide, the devil continued: "Come on, let me show you around."

The tour of the campus lasted about an hour. The more he saw, the less Pastaway understood. Rolling green hills, blooming flowerbeds, beautiful white and brick buildings with imposing stone pillars, trees everywhere, well-equipped laboratories, a library that seemed to have suffered none of the cuts they had endured at Familiar State. It looked like the perfect college campus. "Well, what do you think?" asked the devil. "Will you take the job?" Pastaway figured, correctly, that he did not in fact have any choice, so he answered "Yes." Then he added: "But there is just one thing I don't understand."

The devil raised one eyebrow inquisitively. "Yes?"

"Everything I have seen looks so perfect. The kind of university I have always dreamt of, in fact. And yet, this is Hell. Surely, there must be a catch. There has to be something you have not shown me. Is there a problem with the endowment, perhaps?"

"No, the endowment is very healthy," the devil replied. "But you are right, there is one thing I haven't told you."

"Yes, go on," Pastaway urged.

The devil leant towards him and lowered his voice to a whisper as he said, "We have separate departments for pure and applied mathematics."

The story is an old one. It came to mind on three separate occasions during the past few weeks. First there was the arrival on my desk of this month's personal opinion piece, written by MIT's Gian-Carlo Rota. Then I attended a week-long workshop on "The Visualization of Geometric Structures" held at the Mathematical Sciences Research Institute at Berkeley in the second week of October. Finally, I came across the new book *The Art of Mathematics*, by Lehigh University's Jerry King (Plenum, 1992).

Rota's piece gently chides us for the politically unwise manner in which we mathematicians sometimes conduct our affairs within our home institutions. So often we appear not to realize that arguments such as "Because it is the logical thing to do" rarely impress hard-pressed administrators, even if the logic does in fact happen to be sound. And one of our worst mistakes is, I feel, the way we divide up into small, warring factions, pure versus applied being one of the more dramatic chasms that so often splits us apart (though not the only one).

The MSRI workshop brought home the essential futility of this artificial divide quite clearly, since the growing use of computer visualization tools has made bedfellows of pure and applied mathematicians alike, to the clear benefit of both. (Mind you, in so doing it has created a completely new source of division within pure mathematics, the one that separates the experimenters and the "picture drawers" on the one side from the theorem-proof disciples on the other. There was little in the way of theorems and proofs on display at MSRI that week.)

Of the pure versus applied divide, King says, on page 25 of his book: "In the university, there is no hostility more bitter than that existing between the mathematician who is clearly on one side and the mathematician unequivocally on the other."

This is just the start. In fact, it is not even that. King comes out with guns blazing. Ostensibly written for non-mathematicians, his main audience, or should I say target, seems to me to be the mathematical community itself. And his colors get nailed to the mast as early as page 5, when he quotes G. H. Hardy's statement in *A Mathematician's Apology:*

> *"The function of a mathematician is . . . not to talk about what he or other mathematicians have done. There is no scorn more profound, or on the whole more justifiable, than that of the men who make for the men who explain. Exposition, criticism, appreciation, is the work for second-rate minds."*

A curious view that is almost unique to mathematics, and one which King challenges at some length and with considerable eloquence.

Given the negative attitude towards both exposition and education that one often encounters in the mathematics community at large, it is hardly surprising that, just three pages beyond the Hardy quotation, King makes the suggestion that "If war is too important to be left to generals, then, for analogous reasons, mathematics education may be too important to be left to mathematicians." Given our overall performance in the classroom over the past couple of decades, he may have a point, though that particular tide does seem to be turning of late. It is to be hoped that King's book finds its way onto many a mathematician's desk. In the technology- and defense-driven years of the sixties and seventies, mathematicians found themselves in a privileged position within the academic world. All those science and engineering students needed mathematics, and lots of it. Administrators were, by and large, both ignorant and afraid of the subject, and so the mathematicians were left in almost sole control. Mathematics departments grew, research funding flowed, and the "Hardy scorn" for exposition and education came to dominate, as our classes grew larger and the students in those classes saw a genuine professor less and less. But times have changed, and our previous privilege and self-imposed isolation has left us with few friends, King argues.

King's point is certainly not to attack mathematical research, it should be pointed out. What upsets him is that we do not (or at least largely have not) convey that research-driven vitality and breadth of our subject either to our students or to our colleagues in other disciplines. Moreover, we fail to communicate the aesthetics of the subject, leaving the hapless student, and through them their professors in other departments, with the impression that our subject consists largely of a ragbag of dull, manipulative, algorithmic routines.

What King argues for is a lot of fence mending and a realization that our days of privilege are over. I urge you to read what he has to say. Don't be misled by those oh-so-familiar bits of popular mathematics exposition in the middle part of his book. These may or may not succeed in selling the book to non-mathematicians. But their presence does not prevent the remainder of what King says hitting the target full on. And that target is ourselves.

Keith Devlin

The above is the opinion of the FOCUS editor, and does not necessarily represent the official view of the MAA

PERSONAL OPINION

Ten rules for the survival of a mathematics department

Gian-Carlo Rota

Times are changing, and mathematics, once the queen of the sciences and the undisputed source of research funds, is now being squalidly shoved aside in favor of fields which are (wrongly) presumed to have applications, either because they endow themselves with a catchy terminology, or because they know (better than mathematicians do or ever did) how to make use of the latest techniques in PR. The present note was written as a message of warning to a colleague who insisted that all is well and nothing can happen to us mathematicians as long as we keep proving deep theorems.

1. NEVER WASH YOUR DIRTY LINEN IN PUBLIC

I know that you frequently (and loudly, if I may add) disagree with your colleagues about the relative value of fields of mathematics and about the talents of practicing mathematicians. All of us hold some of our colleagues in low esteem, and sometimes we cannot help ourselves from sharing these opinions with our fellow mathematicians.

When talking to your colleagues in other departments, however, these opinions should never be brought up. It is a mistake for you to think that you might thereby gather support against mathematicians you do not like. What your colleagues in other departments will do instead, after listening to you, is use your statements as proof of the weakness of the whole mathematics department, to increase their own departments' standing at the expense of mathematics.

Departments at a university are like sovereign states: there is no such thing as charity towards one another.

2. NEVER GO ABOVE THE HEAD OF YOUR DEPARTMENT

When a dean or a provost receives a letter from a distinguished faculty member like you which ignores your chairman's opinion, his or her reaction is likely to be one of irritation. It matters little what the content of the letter might be. You see, the letter you have sent forces him or her to think on matters that he or she thought should be dealt with by the chairman of your department. Your letter will be viewed as evidence of disunity in the rank and file of mathematicians.

Human nature being what it is, such a dean or provost is likely to remember an unsolicited letter at budget time, and not very kindly at that.

3. NEVER COMPARE FIELDS

You are not alone in believing that your own field is better and more promising than those of your colleagues. We all believe the same about our own fields. But our beliefs cancel each other out. Better keep your mouth shut, rather than making yourself obnoxious. And remember, when talking to outsiders, you shall have nothing but praise for your colleagues in all fields, even for those in combinatorics. All public shows of disunity are ultimately fatal to the well-being of mathematics.

4. REMEMBER THAT THE GROCERY BILL IS A PIECE OF MATHEMATICS, TOO

Once, when spending a year at a liberal arts college, I was assigned to teach a course on what some like to call "Mickey Mouse Math." I was stung by a colleague's remark that the course "did not deal with real mathematics." It certainly wasn't a course in physics or chemistry, so what was it?

We tend to use the word "mathematics" in a valuative sense, to denote the kind of mathematics we and our friends do. But this is a mistake. The word "mathematics" is more correctly used in a strictly objective sense. The grocery bill, a computer program, and class field theory are three instances of mathematics. Your opinion that some instances may be better than others is most effectively verbalized when you are asked to vote on a tenure decision. At other times, a careless statement of relative values is likely to turn potential friends of mathematics into enemies of our field. Believe me, we are going to need all the friends we can get.

5. DO NOT LOOK DOWN ON GOOD TEACHERS

Mathematics is the greatest undertaking of mankind. All mathematicians know this for a fact. Shocking as it may sound to us, many people out there do not share this view. As a consequence, mathematics is not as self-supporting a profession in our society as the exercise of poetry was in medieval Ireland. Most of our income will have to come from teaching, and the more students we teach, the more of our friends we can appoint to our department. Those few colleagues of ours who are successful at teaching undergraduate courses should earn our thanks, as well as our respect. It is counterproductive to turn our noses at those who bring home the dough.

When Mr. Smith dies and decides to leave his fortune to our mathematics department, it will be because he remembers his good teacher Dr. Jones who never made it beyond associate professor, not just because of the wonderful research papers you have written.

6. WRITE EXPOSITORY PAPERS

When I was in graduate school, one of my teachers told me: "When you write a research paper, you are afraid that your result might already be known; but when you write an expository paper, you discover that nothing is known."

Not only is it good for you to write an expository paper once in a while, but such writing is essential for the survival of mathematics. Look at the most influential writings in mathematics of the last hundred years. At least half of them, from Hilbert's *Zahlbericht* on down, would have to be classified as expository.

Let me tell it to you in the PR language that you detest. It is not enough for you (or anyone) to have a good product to sell; you must package it right and advertise it properly. Otherwise, you will go out of business.

Now don't tell me that you are a pure mathematician and that therefore you stand above and beyond such lowly details. It is the results of pure mathematics, rather than those of applied mathematics, that are most sought after by physicists and engineers (and soon, we hope,by biologists as well). Let us do our best to make our results available to them in a language they can understand. If we don't, they will someday no longer believe we have any new results, and they will cut off our research funds. Remember, they are the ones who control the purse strings, since we mathematicians have always proven to be inept at all political and financial matters.

7. DO NOT SHOW YOUR QUESTIONERS TO THE DOOR

When an engineer knocks at your door with a mathematical question, you should not try to get rid of him or her as quickly as possible. You are likely to make a mistake I myself made for many years: to believe

*Please see **Personal Opinion** on page 14*

Personal Opinion from page 13

that the engineer wants you to solve his or her problem. This is the kind of oversimplification for which we mathematicians are notorious. Believe me, the engineer does not want you to solve his or her problem. Once, I did so by mistake (actually, I had read the solution in the library two hours earlier, quite by accident), and he got quite furious, as if I were taking away his livelihood. What the engineer wants is to be treated with respect and consideration, like the human being he or she is, and most of all to be listened to in rapt attention. If you do this, he or she will be likely to hit upon a clever new idea as he or she explains the problem to you, and you will get some of the credit.

Listening to engineers and other scientists is part of our duty. You may even occasionally learn some interesting new mathematics while doing so.

8. View the Mathematical Community as a United Front

Grade school teachers, high school teachers of mathematics, administrators, and lobbyists are as much mathematicians as you or Hilbert. It is not up to us to make invidious distinctions. They contribute to the well-being of mathematics as much or more than you or many other research mathematicians. They are right in feeling left out by snobbish research mathematicians who do not know which way their bread is buttered. It is in our best interest, as well as in the interest of justice, to treat all who deal with mathematics, in whichever way, as equals. By being united we will increase the probability of our survival.

9. Attack Flakiness

Now that communism is a dead duck, we need a new *Threat*. Remember, Congress reacts only to potential or actual threats (through no fault of their own; it is the way the system works). Flakiness is nowadays creeping into the sciences like a virus through a computer system, and it may be the greatest present threat to our civilization. Mathematics can save the world from the invasion of the flakes by unmasking them, and by contributing some hard thinking. You and I know that mathematics, by definition, is not and never will be flaky.

This is perhaps the biggest chance we have had in a long while to make a lasting contribution to the well-being of science. Let us not botch it like we did with the other few chances we have had in the past.

10. Learn When to Withdraw

Let me confess to you something I have told very few others (after all, this message will not get around much): I have written some of the papers I like the most while hiding in a closet. When the going gets rough, we have recourse to a way of salvation that is not available to ordinary mortals: we have that mighty fortress that is our mathematics. This is what makes us mathematicians into very special people. The danger is envy from the rest of the world.

When you meet someone who does not know how to differentiate and integrate, be kind, gentle, understanding. Remember, there are lots of people like that out there and, if we are not careful, they will do away with us, as has happened many times before in history to other very special people.

And believe yours as ever,

Gian-Carlo Rota.

***Gian-Carlo Rota** is Professor of Mathematics at MIT, Cambridge, MA 02139. The views expressed above are Professor Rota's and do not necessarily reflect the official view of the MAA.*

Strengthening Underrepresented Minority Mathematics Achievement (SUMMA)

1993 Small Grants for Development of Mathematics-Based Intervention Projects

The SUMMA Program of the MAA hopes to award several small grants for the development of mathematics-based intervention projects. SUMMA is soliciting college and university mathematicians and their departments and institutions to submit planning proposals for the advance work necessary to host mathematics-based intervention projects for **middle and high school students**, targeting underrepresented minority students. These projects may replicate existing successful projects, adapt components of such projects, or be innovative. In any case the planned activities should include those characteristics that are known to exist in successful projects. Contact SUMMA for more details.

Objectives

Specifically, the objectives of the SUMMA SMALL GRANTS PROGRAM are to encourage mathematicians to develop projects to increase minority participation in mathematics, and to provide support to project directors for the following: provide funds for project directors to visit established projects; make it possible for the project director to work with the host institution to recruit faculty and in other ways develop the foundation for the project; carry out a feasibility study; providing the project director the opportunity to participate in a proposal writing workshop; secure technical assistance in proposal writing and fund raising; and make it possible for the project director to contact private foundations, public agencies, and industry for support of the project.

Nature of the Grant

Grants are expected to average $5,000 and will be made to the institution of the project director to be spent within the year. To provide maximum flexibility unexpended funds may be carried forward. An institution is expected to supply matching funds or in-kind support as an indication of commitment to the development of the project. Matching funds may be release time, clerical help, or the like. **While the MAA/SUMMA will fund the planning activities it will not fund the project itself. These grants will not support any institutional indirect costs**.

Who May Apply

Grants will be made to faculty at minority institutions, or colleges and universities which have student bodies with a high percentage of underrepresented minorities (at least 20%) and a track record of success in developing minority students' interest in mathematics and science, or colleges and universities in which the institution or department has demonstrated that the faculty have the willingness and capacity to replicate or adapt successful projects.

Evaluation of Proposals

Proposals will be evaluated by members of the MAA Committee on Minority Participation in Mathematics, the Director of SUMMA, and the Executive Director of the MAA.

The 3 page (maximum—single-spaced) proposal should include a description of your proposed project as well as

- **Rationale:** Why is there a need for an intervention project at your institution?
- **Objectives:** What are the objective(s) of your planning project?
- **Methodology:** What tasks and activities will you perform to prepare your proposal?
- **Personnel:** What are the name, position and qualifications of the proposed project director? Who else will be involved in the planning?

*Please see **SUMMA** on page 21*

A. Wayne Roberts

It was clear to me, when the mathematics community first began to articulate its dissatisfactions with the way calculus was being taught, that no single viewpoint and certainly no single text was going to emerge from the developing flurry of activity. The best hope was not for a universally acclaimed fix, but for a broadly generated eclectic mix—a reservoir of materials from which writers and classroom teachers could freely draw while fashioning their own responses.

One broad base from which to work was provided by the mathematics faculties in the liberal arts colleges joined together in two consortia with which I was familiar, the Associated Colleges of the Midwest and the Great Lakes Colleges Association (see footnote). These faculties direct all their energies to undergraduate education, and typically lavish on calculus the same attention a graduate faculty might give to its introductory analysis course.

These schools, in their totality, were equipped with most varieties of computer labs, and they included many people who had become national leaders in the use of computer algebra systems. Their size and disposition enabled them to implement new ideas, to evaluate them, and to reverse themselves when failure is apparent; indeed, they are practiced in going in several directions at once.

FIVE AREAS WERE IDENTIFIED WHERE THERE SEEMED TO BE A NEED FOR MATERIALS:

1. Good questions and suggested experiments should be available so that students who are equipped with electronic aids might discover for themselves ideas traditionally taught as the culmination of carefully orchestrated theoretic considerations.

2. Drill problems, designed to develop mastery and a sense of progress in one's study, should be formulated with the idea that students may have graphing calculators or computers at hand. At the least, they should not be rendered trivial by such aids; at best, such aids should make it possible to direct attention more to ideas than to techniques.

3. There should be available some self–contained accounts of applications of calculus that are modern in spirit, tractable, relevant, and interesting to students.

4. Open-ended projects are needed that require outside reading and consultation, cooperation with other students, and coherent writing that defends both the methodology and the conclusion.

5. Readings should be available that set the subject into historical and intellectual context.

We are not the only ones, of course, to have identified needs along these lines, or to have produced corresponding materials. It has been our idea, however, to serve as a kind of depository for ideas as they have emerged in various projects. While explaining that this project was not featured in *Priming the Calculus Pump* because it did "not aim to develop a particular model of a course that others might wish to emulate," Tom Tucker wrote that "this project may, however, create one of the most

Japanese University Entrance Examination Problems in Mathematics

大学入試

Edited by Ling-Erl Eileen T. Wu

The Mathematical Association of America

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Introduction

In Japan, higher education is considered to be one of the most important factors in obtaining a good job. Consequently, one's social status depends greatly on the level and quality of one's education. Since Japan is a fairly affluent nation, most families can afford higher education for their children. However, with a limited number of prestigious universities, competition on the entrance exam is very keen. Although the overall acceptance rate at four-year institutions in recent years has been above 60%, the acceptance rate at national and local public universities has been only 26%. As a result even at the elementary school level some Tokyo students attend additional evening or Saturday classes to prepare for the entrance examination for the best private junior high schools (grades 7, 8, 9) and high schools (grades 10, 11, 12) in order to be well prepared for the university entrance examination.

The purpose of this report is to give samples of Japanese entrance examinations in the field of mathematics along with the performance results of the 1990 examination. It is hoped that a better understanding of the level of mathematics expected of Japanese students will give mathematics educators in the U. S. a basis for comparison when reviewing the U. S. secondary school mathematics curriculum and expectation of student performance.

The editor deeply appreciates the generous assistance of Professor Hiroshi Fujita of Meiji University, Tokyo, Japan in obtaining the data. Professor Fujita is a member of the committee currently reviewing the Japanese national curriculum and is in charge of the Senior High School Mathematics Division of the Council for Educational Curriculum. He has presented papers on Mathematics Education of the Senior Secondary Level in Japan at the National Council of Teachers of Mathematics (NCTM) meetings in the U.S., at the International Congress on Mathematical Education (ICME) in Budapest, and at other international conferences. The editor also would like to express special thanks to Professor Richard Askey, University of Wisconsin, for his thorough and helpful reading of the manuscript and for his valuable comments and suggestions. The editor sincerely thanks the Alfred P. Sloan Foundation for the financial support which made this project possible. Also special appreciation is due Beverly Ruedi at the MAA for her efficient and excellent work. To the publisher, Obunsha, the author gratefully acknowledges their assistance and cooperation in granting permission to translate material from the "1991 Zenkoku Daigaku Nyuushi Mondai Seikai Suugaku (Kokkouritsudaihen)" [1991 University Entrance Examinations in Mathematics: Problems & Solutions—Edition for National & Local Public Universities]. The editor attempted to give an accurate and readable translation; she accepts full responsibility for any errors that may appear here.

The entrance examination for a national or local public university in Japan consists of two parts:

1. Standardized Primary Exam—UECE

The University Entrance Center Examination (UECE) is administered by a government agency, the Center for University Entrance Examinations. This examination is based on the high school curriculum set forth by the Ministry of Education. Prior to 1990, this examination was called the Joint First Stage Achievement Test (JFSAT). All applicants for national or local public universities are required to take this examination. It is offered once a year, usually in mid-January, with the make-up examination scheduled one week later.

2. Secondary Exam

This additional exam is given independently by each university at a later date. Generally the examination dates for national and local public universities are divided into two types:

(i) Two-stage type—two exam dates, usually two weeks apart, with pre-determined allocation of entrants, about a 9 to 1 ratio.
(ii) AB-date (or ABC-date) type—two (or three) exam dates, A-date and B-date, (and C-date), usually one week apart, uniformly set each year. A-date coincides with First-stage date in (i).

Thus there are four possible paths offering a student two chances to take an entrance exam for a public university:

(a) A-date exam ⟶ B-date exam
(b) A-date exam ⟶ Second-stage exam
(c) First-stage exam ⟶ B-date exam
(d) First-stage exam ⟶ Second-stage exam.

If a student passes the First-stage exam of a university and decides to enter the university, the student is required to proceed with registration shortly after the exam result is known. Then the student loses applicant status for the Second-stage exam or accepted status for the B-date exam, whichever status the student held.

Each university sets the relative weights of the two examination scores in its admissions decisions. The ratio of UECE score weights to the individual university examination weights is typically about 40% to 60%, or 50% to 50%. Tokyo University is an extreme case, setting the ratio of weights at 20% for the UECE score to 80% for the Tokyo University score.

In 1990, about 6% of those admitted to the four-year national or local public universities gained admission by recommendations; some took only the UECE and some were exempt from both the UECE and the individual university examination. Although the recent improvement in secondary examination scheduling enables a student to take two national or local public university exams, most applicants target an exam given on the first date or A-date because an exam given on the second date tends to be more difficult and has a smaller allocation of admittees.

According to the Ministry of Education, about 73% of university students were enrolled in private universities in 1987. In the past, JFSAT was primarily for the national and local public universities and only the individual university examination was required for private universities. When UECE replaced JFSAT in 1990, one of the objectives of the UECE Committee was to make the examination easier for private as well as public universities to utilize. Sixteen of the 342 private universities joined all 132 national and local public universities to participate in 1990. Twenty-one private universities participated in UECE in 1991 and 31 participated in 1992. Currently, most private university applicants do not take the UECE.

Private universities admit a somewhat larger percentage of their students by recommendations. In 1984 the rate was about 20%. In 1991 at Asia University in Tokyo, 40 of the 400 admitted by recommendations were exempt from taking the UECE and the university's entrance examination. Unlike national and local public universities, private universities' entrance examination dates are not uniform, allowing applicants to take many private university examinations. In recent years students have applied to an average of 6 private universities.

Even though the use of UECE in Japan is not yet as widespread as that of the SAT in the U.S., it plays a similar role. See the following table for comparison data.

1987	**Japan***	**U. S.****
Population age 18	1,883,000	3,667,000
High school graduates	1,792,000	2,647,000
Proportion of the age group	95%	72%
High school graduates enrolled in college	681,000	1,503,000
Proportion of HS grads	38%	57%
Proportion of the age group	36%	41%
Number of students who took:		
UECE (formerly JFSAT)	256,000(1)	
SAT		1,134,000
Proportion of HS grads enrolled in college	38%	75%
Proportion of HS grads	14%	43%
Proportion of the age group	14%	31%
Applicants to universities or junior colleges	1,025,000	
Accepted applicants	681,000	2,246,000(2)
Acceptance rate	66%	

The 1990 UECE in mathematics is divided into two sections: Section A consists of Mathematics I and Section B consists of either Mathematics II, Industrial Mathematics, or Accounting/ Statistics I, II. Depending on the student's area of study, he or she will select the appropriate examination in Section B. Of the 327,543 applicants who took Section B in 1990, 327,034 took the Mathematics II, 52 took Industrial Mathematics, and 457 took Accounting/Statistics I, II. Because of the significantly greater number of applicants taking Mathematics I and II, only those two examinations will be considered in the following article.

Ling-Erl Eileen T. Wu
Menlo College

* Data from Monbusho: Outline of Education in Japan, 1989.

** Data from the *1989–90 Fact Book on Higher Education* by American Council on Education and Macmillan Co. and the *Digest of Education Statistics* (Government Printing Office, Washington, DC, 1991).

(1) The figure excludes approximately 138,000 of those who graduated prior to 1987.

(2) First time freshman including H.S. graduates of other years.

1990 UECE in Mathematics

Directions: Each problem contains several blanks. Blanks are represented by bracketed, underlined numbers. Each blank must be filled with a single digit or sign. See the method shown in the following examples and answer in the specified space on the answer sheet:

1. $\{\underline{1}\}, \{\underline{2}\}, \{\underline{3}\}, \{\underline{4}\}, \ldots$ each represent values between 0 and 9 or + or − signs. For example, to indicate -8 as the answer to $\{\underline{1}\}\{\underline{2}\}$, mark

$\{\underline{1}\}$ ⊖ + 0 1 2 3 4 5 6 7 8 9

$\{\underline{2}\}$ − + 0 1 2 3 4 5 6 7 ⑧ 9

2. If the answer is a fraction, reduce the fraction to its lowest terms and indicate the sign in the numerator. For example, to indicate $-2/9$ as the answer to $\{\underline{3}\}\{\underline{4}\}/\{\underline{5}\}$, mark

$\{\underline{3}\}$ ⊖ + 0 1 2 3 4 5 6 7 8 9

$\{\underline{4}\}$ − + 0 1 ② 3 4 5 6 7 8 9

$\{\underline{5}\}$ − + 0 1 2 3 4 5 6 7 8 ⑨

Mathematics A [Mathematics I] (100 points, 60 minutes)

Section 1 (30 points)

1. Suppose the polynomial $P(x)$ with integer coefficients satisfies the following conditions:

(A) If $P(x)$ is divided by $x^2 - 4x + 3$, the remainder is $65x - 68$.

(B) If $P(x)$ is divided by $x^2 + 6x - 7$, the remainder is $-5x + a$.

Then we know that $a = \{\underline{1}\}$.

Let us find the remainder $bx + c$ when $P(x)$ is divided by $x^2 + 4x - 21$.

Condition (A) implies that $\{\underline{2}\}\, b + c = \{\underline{3}\}\{\underline{4}\}\{\underline{5}\}$ and $a = \{\underline{1}\}$. Condition (B) implies that $\{\underline{6}\}\{\underline{7}\}\, b + c = \{\underline{8}\}\{\underline{9}\}$. It follows that $b = \{\underline{10}\}$ and $c = \{\underline{11}\}\{\underline{12}\}\{\underline{13}\}$.

2. Fill in the blanks in statements (A) through (D) with the appropriate phrase [1], [2], [3] or [4] listed below:

(A) Given sets A, B, $A \cup B = A$ is $\{\underline{14}\}$ for $A \cap B = B$.

(B) For some integer n, n^2 being some multiple of 12 is $\{\underline{15}\}$ for n being a multiple of 12.

(C) The center of the circle inscribed in triangle T coinciding with the center of the circle which circumscribes triangle T is $\{\underline{16}\}$ for triangle T to be an equilateral triangle.

(D) Given real numbers a, b, and c,

$$|a + b + c| = |a| + |b| + |c|$$

is $\{\underline{17}\}$ for $ab + bc + ca \geq 0$.

[1] a necessary and sufficient condition

[2] a necessary but not sufficient condition

[3] a sufficient but not necessary condition
[4] neither a sufficient nor a necessary condition

Section 2 (35 points)

Let a be a constant. Consider the parabola

$$C_a : y = -x^2 + ax + a^2.$$

1. Since the coordinates of the vertex of C_a are

$$\left(\frac{a}{\{\underline{1}\}}, \frac{\{\underline{2}\}}{\{\underline{3}\}}a^2\right),$$

the vertex is on the curve $y = \{\underline{4}\}x^2$.

2. Let ℓ be the line joining two points $A\ (-1, 1)$ and $B\ (2, 4)$. For the parabola C_a and the line ℓ to have a common point, the value of a must be

$$a \leq \{\underline{5}\}\{\underline{6}\} \qquad \text{or} \qquad a \geq \frac{\{\underline{7}\}}{\{\underline{8}\}}.$$

The coordinates of the common point of parabola C_a and the line ℓ are

$$(\{\underline{9}\}\{\underline{10}\}, \{\underline{11}\}), \qquad \text{when } a = \{\underline{5}\}\{\underline{6}\}$$

and

$$\left(\frac{\{\underline{12}\}}{\{\underline{13}\}}, \frac{\{\underline{14}\}}{\{\underline{15}\}}\right), \qquad \text{when } a = \frac{\{\underline{7}\}}{\{\underline{8}\}}.$$

Also, in order for the parabola C_a and the line segment AB to have two distinct points of intersection,

$$\frac{\{\underline{16}\}}{\{\underline{17}\}} < a \leq \{\underline{18}\}.$$

Section 3 (35 points)

Consider the triangle ABC with coordinates $A\ (0, 3)$, $B\ (-1, 0)$ and $C\ (2, 1)$.

1. The center of the circumscribed circle is

$$\left(\frac{\{\underline{1}\}}{\{\underline{2}\}}, \frac{\{\underline{3}\}}{\{\underline{4}\}}\right),$$

and the radius is

$$\frac{\{\underline{5}\}\sqrt{\{\underline{6}\}}}{\{\underline{7}\}}.$$

Also,

$$\sin \angle ABC = \frac{\{\underline{8}\}}{\{\underline{9}\}},$$

and the area of triangle ABC is $\{\underline{10}\}$.

From these conditions, we know that the radius of the inscribed circle is

$$\frac{\sqrt{\{\underline{11}\}\{\underline{12}\}} - \sqrt{\{\underline{13}\}}}{\{\underline{14}\}}.$$

2. If point P moves along the sides of triangle ABC, the maximum value of the distance between the origin O and point P is $\{\underline{15}\}$ and the minimum value is

$$\frac{1}{\sqrt{\{\underline{16}\}\{\underline{17}\}}}.$$

Answers to Mathematics A [Mathematics I] (100 points)

Section 1

1.	$a = \{\underline{1}\}$	$a = 2$
	$\{\underline{2}\}b + c = \{\underline{3}\}\{\underline{4}\}\{\underline{5}\}$	$3b + c = 127$
	$\{\underline{6}\}\{\underline{7}\}b + c = \{\underline{8}\}\{\underline{9}\}$	$-7b + c = 37$
	$b = \{\underline{10}\}$	$b = 9$
	$c = \{\underline{11}\}\{\underline{12}\}\{\underline{13}\}$	$c = 100$
2.	$\{\underline{14}\}$	1
	$\{\underline{15}\}$	2
	$\{\underline{16}\}$	1
	$\{\underline{17}\}$	3

Section 2

1.	$\left(\frac{a}{\{\underline{1}\}}, \frac{\{\underline{2}\}}{\{\underline{3}\}}a^2\right)$	$\left(\frac{a}{2}, \frac{5}{4}a^2\right)$
	$\{\underline{4}\}x^2$	$5x^2$
2.	$a \leq \{\underline{5}\}\{\underline{6}\}$	$a \leq -1$
	$a \geq \{\underline{7}\}/\{\underline{8}\}$	$a \geq 7/5$
	$(\{\underline{9}\}\{\underline{10}\}, \{\underline{11}\})$	$(-1, 1)$
	$\left(\frac{\{\underline{12}\}}{\{\underline{13}\}}, \frac{\{\underline{14}\}}{\{\underline{15}\}}\right)$	$\left(\frac{1}{5}, \frac{11}{5}\right)$
	$\{\underline{16}\}/\{\underline{17}\} < a \leq \{\underline{18}\}$	$7/5 < a \leq 2$

Section 3

1.	$\left(\frac{\{\underline{1}\}}{\{\underline{2}\}}, \frac{\{\underline{3}\}}{\{\underline{4}\}}\right)$	$\left(\frac{1}{4}, \frac{5}{4}\right)$
	$\frac{\{\underline{5}\}\sqrt{\{\underline{6}\}}}{\{\underline{7}\}}$	$\frac{5\sqrt{2}}{4}$
	$\frac{\{\underline{8}\}}{\{\underline{9}\}}$	$\frac{4}{5}$
	$\{\underline{10}\}$	4
	$\frac{\sqrt{\{\underline{11}\}\{\underline{12}\}} - \sqrt{\{\underline{13}\}}}{\{\underline{14}\}}$	$\frac{\sqrt{10} - \sqrt{2}}{2}$
2.	$\{\underline{15}\}$	3
	$\frac{1}{\sqrt{\{\underline{16}\}\{\underline{17}\}}}$	$\frac{1}{\sqrt{10}}$

Mathematics B [Mathematics II] (100 points, 60 minutes)

Choose two of the following three sections:

Section 1 (50 points)

1. In a circle with radius 2 and its center at the origin O, let the vertices of an inscribed hexagon be $ABCDEF$, with the coordinates of A at $(2, 0)$, and with B in the first quadrant.

(1) The components of the vector

$$\overrightarrow{AB} + 2\overrightarrow{DE} - 3\overrightarrow{FA}$$

are $\left(\{\underline{1}\}\{\underline{2}\}, \{\underline{3}\}\{\underline{4}\}\sqrt{\{\underline{5}\}}\right)$.

(2) If t is a real number, the magnitude of the vector

$$\overrightarrow{AB} + t\overrightarrow{EF}$$

is a minimum when the value of t is

$$\frac{\{\underline{6}\}}{\{\underline{7}\}}$$

and the minimum magnitude is $\sqrt{\{\underline{8}\}}$.

2. Let $ABCD$ be a quadrilateral with

$$\overrightarrow{BC} = 2\overrightarrow{AD}$$

$$AB = CD = DA = 2$$

$$\overrightarrow{AD} = \vec{a}$$

$$\overrightarrow{BA} = \vec{b}$$

(1) Let M be the midpoint of CD. Since $\angle BCM = \{\underline{9}\}\{\underline{10}\}°$;

$$BM = \sqrt{\{\underline{11}\}\{\underline{12}\}}.$$

Also

$$\overrightarrow{BM} = \frac{\{\underline{13}\}}{\{\underline{14}\}}\vec{a} + \frac{\{\underline{15}\}}{\{\underline{16}\}}\vec{b}. \qquad (1)$$

(2) Let P be a point on AB, and let Q be the point of intersection of PC and BM. Suppose $PQ : QC = 1 : 2$. Let us find $AP : PB$ and $BQ : QM$. If we set

$$\overrightarrow{BP} = t\overrightarrow{BA},$$

we have

$$\overrightarrow{BQ} = \frac{\{\underline{17}\}}{\{\underline{18}\}}(\vec{a} + t\vec{b}). \qquad (2)$$

Therefore, from (1) and (2),

$$t = \frac{\{\underline{19}\}}{\{\underline{20}\}}.$$

It follows that $AP : PB = \{\underline{21}\} : \{\underline{22}\}$, $BQ : QM = \{\underline{23}\} : \{\underline{24}\}$ and

$$BQ = \frac{\{\underline{25}\}}{\{\underline{26}\}}\sqrt{\{\underline{27}\}\{\underline{28}\}}.$$

Section 2 (50 points)

1. The function $f(x) = x^3 + ax^2 + bx$ has the local minimum value $-(2\sqrt{3})/9$ at $x = 1/\sqrt{3}$. Then,

(1) $a = \{\underline{1}\}$, $b = \{\underline{2}\}\{\underline{3}\}$ and the local maximum value of the function $f(x)$ is

$$\frac{\{\underline{4}\}\sqrt{\{\underline{5}\}}}{\{\underline{6}\}}.$$

(2) The value of the slope m of the tangent line at point P on the curve $y = f(x)$ is greater than or equal to $\{\underline{7}\}\{\underline{8}\}$. If $m = \tan\theta$ $(0° \leq \theta < 180°)$, then the range of values for θ is $0° \leq \theta < \{\underline{9}\}\{\underline{10}\}°$ or $\{\underline{11}\}\{\underline{12}\}\{\underline{13}\}° \leq \theta < 180°$.

(3) The volume of the solid generated by revolving the region bounded by the x-axis and the curve $y = f(x)$ about the x-axis is

$$\frac{\{\underline{14}\}\{\underline{15}\}}{\{\underline{16}\}\{\underline{17}\}\{\underline{18}\}}\pi.$$

2. $1, 1/2, 1/2, 1/4, 1/4, 1/4, 1/4, \ldots$ is a sequence where $1/2^{k-1}$ appears 2^k times successively $(k = 1, 2, 3, \ldots)$.

(1) Then the sum of the first 1000 terms is

$$\{\underline{19}\} + \frac{\{\underline{20}\}\{\underline{21}\}\{\underline{22}\}}{2^{\{\underline{23}\}}}.$$

(2) If the sum of the first n terms is 100, then because

$$n = 2^{\{\underline{24}\}\{\underline{25}\}\{\underline{26}\}} - \{\underline{27}\},$$

n is a $\{\underline{28}\}\{\underline{29}\}$ digit number provided that $\log_{10} 2 = 0.3010$.

Section 3 (50 points)

The numbers 1 through 9 are written individually on nine cards. Choose three cards from the nine, letting x, y, and z denote the numbers of the cards arranged in increasing order.

1. There are $\{\underline{1}\}\{\underline{2}\}$ such x, y, and z combinations.

2. The probability of having x, y, and z all even is

$$\frac{\{\underline{3}\}}{\{\underline{4}\}\{\underline{5}\}}.$$

3. The probability of having x, y, and z be consecutive numbers is

$$\frac{\{\underline{6}\}}{\{\underline{7}\}\{\underline{8}\}}.$$

4. The probability of having $x = 4$ is

$$\frac{\{\underline{9}\}}{\{\underline{10}\}\{\underline{11}\}}.$$

5. Possible values of x range from $\{\underline{12}\}$ to $\{\underline{13}\}$. If k is an integer such that $\{\underline{12}\} \leq k \leq \{\underline{13}\}$, the probability of $x = k$ is

$$\frac{(\{\underline{14}\} - k)(\{\underline{15}\} - k)}{\{\underline{16}\}\{\underline{17}\}\{\underline{18}\}}.$$

The expected value of x is

$$\frac{\{\underline{19}\}}{\{\underline{20}\}}.$$

Answers to Mathematics B [Mathematics II] (100 points)

Section 1

1.	$(\{\underline{1}\}\{\underline{2}\}, \{\underline{3}\}\{\underline{4}\}\sqrt{\{\underline{5}\}})$	$(-4, -4\sqrt{3})$
	$\{\underline{6}\}/\{\underline{7}\}$	$1/2$
	$\sqrt{\{\underline{8}\}}$	$\sqrt{3}$
2.	$\{\underline{9}\}\{\underline{10}\}$	60
	$\sqrt{\{\underline{11}\}\{\underline{12}\}}$	$\sqrt{13}$
	$\frac{\{\underline{13}\}}{\{\underline{14}\}}\vec{a} + \frac{\{\underline{15}\}}{\{\underline{16}\}}\vec{b}$	$\frac{3}{2}\vec{a} + \frac{1}{2}\vec{b}$
3.	$\{\underline{17}\}/\{\underline{18}\}$	$2/3$
	$\{\underline{19}\}/\{\underline{20}\}$	$1/3$
	$\{\underline{21}\} : \{\underline{22}\}$	$2 : 1$
	$\{\underline{23}\} : \{\underline{24}\}$	$4 : 5$
	$\frac{\{\underline{25}\}}{\{\underline{26}\}}\sqrt{\{\underline{27}\}\{\underline{28}\}}$	$\frac{4}{9}\sqrt{13}$

Section 2

1.	$\{\underline{1}\}$	0
	$\{\underline{2}\}\{\underline{3}\}$	-1
	$\frac{\{\underline{4}\}\sqrt{\{\underline{5}\}}}{\{\underline{6}\}}$	$\frac{2\sqrt{3}}{9}$
	$\{\underline{7}\}\{\underline{8}\}$	-1
	$\{\underline{9}\}\{\underline{10}\}$	90
	$\{\underline{11}\}\{\underline{12}\}\{\underline{13}\}$	135
	$\frac{\{\underline{14}\}\{\underline{15}\}}{\{\underline{16}\}\{\underline{17}\}\{\underline{18}\}}$	$\frac{16}{105}$
2.	$\{\underline{19}\}$	9
	$\frac{\{\underline{20}\}\{\underline{21}\}\{\underline{22}\}}{2^{\{\underline{23}\}}}$	$\frac{489}{2^9}$
	$n = 2^{\{\underline{24}\}\{\underline{25}\}\{\underline{26}\}} - \{\underline{27}\}$	$n = 2^{100} - 1$
	$\{\underline{28}\}\{\underline{29}\}$	31

Section 3

1.	$\{\underline{1}\}\{\underline{2}\}$	84
2.	$\frac{\{\underline{3}\}}{\{\underline{4}\}\{\underline{5}\}}$	$\frac{1}{21}$
3.	$\frac{\{\underline{6}\}}{\{\underline{7}\}\{\underline{8}\}}$	$\frac{1}{12}$
4.	$\frac{\{\underline{9}\}}{\{\underline{10}\}\{\underline{11}\}}$	$\frac{5}{42}$
5.	$\{\underline{12}\}, \{\underline{13}\}$	1, 7
	$\frac{(\{\underline{14}\} - k)(\{\underline{15}\} - k)}{\{\underline{16}\}\{\underline{17}\}\{\underline{18}\}}$	$\frac{(9-k)(8-k)}{168}$ or $\frac{(8-k)(9-k)}{168}$
	$\frac{\{\underline{19}\}}{\{\underline{20}\}}$	$\frac{5}{2}$

Results of Performance on 1990 UECE

EXAMINATION	Number of Participants	Average	High	Low	Standard Deviation
MATHEMATICS A					
Mathematics I	353,010	73.37	100	0	23.43
MATHEMATICS B					
Mathematics II	327,034	64.27	100	0	22.62
Industrial Math.	52	40.87	91	0	23.69
Accounting/Stat. I, II	457	62.42	99	11	17.84

Evaluation of the 1990 University Entrance Center Examination (Direct translation of the text)

I. Opinions of and Evaluations by Senior High School Teachers

1. Preface

Discussions and research into establishing a more suitable university entrance examination to accommodate a great increase in the number and diversity of university applicants have allowed private universities to participate along with the national universities.

Accordingly, we revised the contents of the examinations. Originally, Math I and Math II combined were 100 minutes, 200 points; the UECE in mathematics is currently divided into two groups: Math A [Math I] and Math B [Math II], each exam being 60 minutes long and worth 100 points.

The purpose of the UECE is, as before, to assess the degree of mastery of the general fundamental learning established for the senior high schools. Considering the various ways the UECE is utilized in selecting university entrants, fairness to the exam participants was emphasized by posing the following questions:

(1) whether exam problems (content, questions, score distributions, format, etc.) accurately assess the level of fundamental learning;
(2) whether there is a wide difference in the degree of difficulty between the main exam and the make-up exam;
(3) whether there is a great difference in the degree of difficulty among optional problem sections.

With these criteria in mind, we will analyze the 1990 exam problems from the following points of view:

(1) whether the exam problems fulfill the purpose of the UECE exam;
(2) whether Math I, Math II are consistent with the guidelines set forth by the senior high schools;
(3) whether the content of exam problems tends to be esoteric;
(4) whether the degree of difficulty of optional problem sections for Math II is uniform in the three sections;
(5) whether the problems provide sufficient information to evaluate the student's mathematical thinking ability and ability to perform calculations;
(6) whether, for each problem, the level of difficulty, the method of questioning, the distribution of points, format, and so forth are appropriate;
(7) whether the problems reflect an improvement resulting from reviewing the past JFSAT and the Trial Center Exam administered in 1988.

2. Content and Scope of the Exam Problems

Mathematics I

Section 1. Numbers and expressions, equations and inequalities

1. Polynomials with integer coefficients and equations
Using the two conditions given and the remainder theorem, divide the integral expression by the second-degree expression.

2. Proofs and statements
Covering combinations, integers, graphs and inequalities from Math I, determine whether the condition given in each part is necessary, sufficient, or both.

Section 2. Functions, two-dimensional graphs and expressions

1. Find the coordinates of the vertex of a parabola and the equation of its locus.

2. Find the condition for having common points between the line joining the given two points and the parabola, and find the coordinates of the common points. Also, find the condition that the line segment AB and the parabola have two distinct common points.

Section 3. Two-dimensional graphs and related expressions, trigonometric ratios

1. Find the center and the radius of the circle passing through three points A, B, and C in a plane. Also, find $\sin\angle ABC$ and the area of $\triangle ABC$ using either the law of sines or the law of cosines. Then find the radius of the inscribed circle.

2. Find the maximum and minimum distances between the origin and a point on a side of $\triangle ABC$.

Mathematics II

Section 1. Vectors

1. Coordinatized two-dimensional vectors
(1) Determine the coordinates of the given points and then find the components of the vector.
(2) Find the minimum value of the magnitude of the vector.

2. Two-dimensional vectors
(1) Using the conditions given for the vectors, draw the graph and find the angle. Using the law of cosines, find the length of a side. Also, express the vector in terms of two linearly independent vectors $\overrightarrow{a}$ and $\overrightarrow{b}$.

Section 2. Progressions, derivatives, integrals, and trigonometric functions

1. Derivatives, integrals, and trigonometric functions
(1) Determine the coefficients from the information given about the minimum value of the function. Also determine the maximum value of the function.
(2) Make use of the derivative to find the minimum value for the slope. Find the range of the angle formed by the tangent and the positive x-axis.
(3) Find the volume of the solid generated by revolving the region bounded by the curve and the x-axis about the x-axis.

2. Progressions and logarithms
(1) Consider the pattern of the progression, and make use of the sum formula for the geometric progression. This problem is beyond the curriculum guidelines established for the senior high schools and requires special effort.
(2) Given the sum, use the geometric progression to determine the number of terms n. Also, use the common logarithm to find the digits of n.

3. Probability
(1) Determine the value of the combination.
(2) Determine the probability of choosing three numbers from $\{2,4,6,8\}$.
(3) Determine the probability of choosing three consecutive numbers.
(4) Determine the probability of choosing three numbers, of which 4 is the smallest number.
(5) If the smallest of three numbers is k, find the range for k. Also find the probability of k being the smallest number and then find the expected value of the smallest number.

3. Analysis of the Exam Problems

Mathematics I

Section 1

1. This basic problem using the remainder theorem is typical for a university entrance exam. If one knows the remainder theorem, it is unthinkable that one should miss this problem, aside from errors in calculations. This problem is suitable for testing the level of the basic learning established for senior high schools.

2. The format for this problem on expressions and proofs is multiple-choice because it was assumed that more participants could answer the problems intuitively.

(1) In set theory, $(A \cup B) \supset B$ and $A \supset (A \cap B)$ are basic knowledge, but the senior high school textbooks do not cover this in detail. We think that many answered hastily without considering the proof.

(2) If n is a multiple of 12, then n^2 is a multiple of 12. This is obvious. To disprove the converse is not too difficult.

(3) If T is an equilateral triangle, then the center of the inscribed circle and that of the circumscribed circle coincide. This can be proven with the knowledge gained from junior high school mathematics. We think many chose the answer [A] without considering the proof.

(4) Perhaps it did not occur to the students to square both sides of

$$|a+b+c| = |a| + |b| + |c|$$

and even if it had occurred to them, it would have appeared that finding a counterexample to the converse required too much time and work. We feel that more students considered the problem intuitively.

In these types of multiple-choice questions, it is difficult to see the logical thinking process. We would like to see an improvement made in the problem format; one which emphasizes the thought process that leads to the conclusion, rather than a format that encourages guessing the answer to the problem. We assume that this type of theorem-proof problem develops logical thinking.

Section 2

1. This is a basic problem. We think that the short questions in the first part were easy and not confusing. The coordinates of the vertex can be obtained from the standard second-degree form. The equation of the locus can be found easily by eliminating the parameter a. This problem expresses the parabola by C_a, a notation rarely used in textbooks.

2. Parts $\{\underline{1}\}$ through $\{\underline{15}\}$ are textbook-level basic questions which are considered easy to solve. For the remaining parts, it is important to keep in mind that

$$x^2 - (a-1)x - a^2 + 2 = 0 \quad \text{and} \quad -1 \le x \le 2$$

in order to have two distinct real solutions. This is a good question to test graphing ability and mathematical thinking. We feel participants were unfamiliar with this type of problem; they either thought that they did not have enough conditions or miscalculated somewhere. Overall, the number of questions and the distribution of points are well-balanced. These are good standard questions.

Section 3

1. In order to find the center of the circumscribed circle of $\triangle ABC$, solve a system of simultaneous equations by setting the equation of the circumscribed circle to be

$$x^2 + y^2 + ax + by + c = 0,$$

or solve for the intersecting point of two perpendicular bisectors of the sides. We suspect that there were students who did not follow the proper order in these questions and who used $\sin \angle ABC$ in the next part to solve for the radius of the circumscribed circle. The radius of the inscribed circle can be obtained by the formula

$$S = rs.$$

Depending on the textbook, the exact specification of this formula varies.

2. The shortest distance between the origin O and the point P can be found simply by using the formula for the distance between a point and a line. Since the forms of the formula vary depending on the textbook, this problem requires some work. Overall, it is a good question. There is no objection to its level, distribution of points, or format.

Mathematics II

Section 1

1. (1) The positions of the vertices of the regular hexagon can be obtained by using the trigonometric ratios or symmetric points. We think it might have been better to ask the participants to find the coordinates of point B or point F before asking (1).

(2) Expressing the components of the vector

$$\overrightarrow{AB} + t\overrightarrow{EF},$$

the minimum value of the magnitude of this vector can be found from a second-degree function in t. Because there is another way to solve the problem using the inner product, the problem should be designed to ensure fairness to all participants.

2. (1) BM can be obtained by the law of cosines or the Pythagorean theorem. Considering

$$\overrightarrow{BM}$$

as the midpoint vector of CD, BM can be found easily. Students easily solved this problem.

(2) From

$$\overrightarrow{BQ} = 1/3\left(2\overrightarrow{BP} + \overrightarrow{BC}\right),$$

one can find

$$\frac{\{\underline{17}\}}{\{\underline{18}\}}.$$

Setting

$$\overrightarrow{BM} = k\overrightarrow{BQ},$$

from the fact that $\overrightarrow{a}$ and $\overrightarrow{b}$ are linearly independent, one can find the value of t. From this fact, $\{\underline{21}\}$, $\{\underline{22}\}$, $\{\underline{23}\}$, and $\{\underline{24}\}$ can be found. In particular, when making use of equation (1) to find BQ, we think some students gave up in the middle of the process due to lack of graphic observation. Although it was stated in the problem that

$$\overrightarrow{BA} = \vec{b},$$

it might have been clearer if it had been specified that

$$\overrightarrow{AB} = \vec{b} \quad \text{because} \quad \overrightarrow{AD} = \vec{a}.$$

Section 1 is a set of good questions which tie the graphs to the vectors. In terms of the level of difficulty, distribution of points, and format, they are well-constructed questions which determine whether basic concepts are well understood.

Section 2

1. (1) All are basic problems.

(2) We can see that an effort was made to demonstrate the steps in a general problem dealing with differentiation and trigonometric functions.

(3) Here is a basic problem with calculations that are not very complex. Overall, (3) is a good question. However, if (1) is not solved, then (2) and (3) cannot be solved, and the motive for asking (2) and (3) is lost. We hope to see a modification in the problem format.

2. (1) The steps for these problems were very difficult for the students. We would like to have first asked a more concrete question such as "find the sum of the first 10 terms" to demonstrate the pattern. Eight points are assigned for answers $\{\underline{20}\}$ through $\{\underline{23}\}$. In order to give credit for steps in the solving process, we would have preferred to assign 4 points to the numerator and 4 points to the denominator.

(2) If one observes that there are 2^{k-1} terms of $1/(2^{k-1})$ and that these terms sum to 1, the problem can be easily solved; however, it was probably a very hard question for those who were unaccustomed to this concept. Also, regarding the problems on the number of the digits, if one had not observed that

$$\log(2^{100} - 1) \approx \log 2^{100},$$

or if one were not accustomed to dealing with logarithms, we think this problem would be difficult to solve. Part 2 is a good application problem involving progressions and testing mathematical thinking ability; however, we think the problem is beyond the scope of textbooks, and we would have liked to have seen a concrete example leading step-by-step to the solution.

Section 3

1. Basic problem. Because of the nature of probability, the answer to (1) is related to all parts in (2) and all parts thereafter. It is an appropriate question.

2. Basic problem.

3. If one observes that once x is determined, y, z are determined, then it is a simple and basic problem.

4. Selecting y and z is the same as finding the combination of selecting 2 cards from 5 cards which are marked 5, 6, 7, 8, and 9. This is also a basic problem.

5. From $\{\underline{12}\}$, $\{\underline{13}\}$, one can solve the problem if one understands the point of the question. To find the probability of $x = k$, one can generalize the method for 4. Since the students might not have been accustomed to calculating combinations involving a letter (rather than a number), we consider this a bad problem.

Section 3 is a set of good questions overall.

4. Summary

A summary of those points we felt strongly about on this year's Center Examination and a record of our suggestions follows:

1. This year's averages are 73 for Math I and 64 for Math II, higher than the target scores of 60%. It has won much approval from senior high school teachers. Overall, there are many good, standard problems with well-researched content. The problems were appropriate for testing the degree of achievement in the senior high schools.

2. The content of Math I was sufficiently consistent with the content in the learning guidelines for the senior high schools. In Math II, the content of Sections 1 and 2 were adequate, but the level of Section 2.2 on grouped progressions was beyond the scope of the textbooks used. However, this type of application problem is useful in determining the student's innovative mathematical thinking ability. It is hoped that an improved form of the question can be developed.

3. The problem on progressions crosses the entire range of Math I and Math II. There were many good questions testing the student's ability to integrate their mathematical knowledge. We do not consider the content obscure, but rather well-balanced.

4. The optional problem sections in Math II were all expected to have been of the same level of difficulty, but Section 2.2 included a progression which students were not used to, making the problem difficult. There is considerable disparity between the levels of difficulty in Sections 1 and 2. For a higher level problem like 2.2, we would have liked to have seen more attention devoted to the questioning method and to suggest such approaches as giving a concrete example and asking the question in parts.

5. The 1990 exam problems are consistently appropriate for evaluating basic mathematical thinking and calculation ability. We see the intent of the UECE as testing the student's mastery of essential mathematical material. For Math I, Section 1.2, we would like to see an additional true-false section, more testing of the problem-solving thought process, and the elimination of ambiguous questions.

6. For JFSAT, the exam time for both Math I and Math II combined was 100 minutes. For UECE, though the time allotted for simple problems was transferred to harder problems within each exam, it seemed that 60 minutes each for Math I and Math II was not sufficient. In order to determine more accurately the student's mathematical ability, we wonder if it is possible to cover the same material and shorten the rest period in order to lengthen each testing period to 80 minutes.

7. As for topics covered, the exam has been improved by the inclusion of problems on progressions, reflecting efforts to respond to earlier criticisms and suggestions. To devise fair, valid problems is a difficult task, but we hope that efforts toward this goal will be continued.

II. Analysis of 1990 UECE by Division of Research, Senior High School Division, Association of Japanese Mathematical Education

1. Guidelines for Exam Problems

The University Entrance Center Examination (UECE) was given for the first time this year. The previous JFSAT [Math I, Math II] was divided into Math A [Math I] and Math B [Math II], each exam being 60 minutes long and worth 100 points. The basic guidelines of the exam problems have not been changed; the UECE is designed to measure the student's level of mathematical achievement in the senior high school. The exam is to be used by individual universities to select entrants.

In order to evaluate the student's achievement in basic mathematics, we need to avoid ambiguous or misleading problems. The exam problems should be such that students could answer them solely on the basis of their understanding of the textbooks and their ability to apply that understanding; the scores should accurately reflect the level of understanding of the problems. Since this exam is one criterion used for judging a university entrant, we must, of course, avoid problems which all students can solve and problems which none can solve. Particularly for those universities which do not require math in the secondary examination, we need to ensure that exam problems provide sufficient information for the selection of the entrants. Also, the degree of the difficulty of the optional problem sections in Math II should not be widely disparate.

2. On This Year's Problems

1. In keeping with the above mentioned guidelines, we devised problems of the appropriate level by taking the following into account:

i. the results of the analysis of the previous JFSAT;
ii. the report of the 1989 exam committee regarding points needing to be addressed in future exams;
iii. opinions and criticisms of senior high school teachers and the Association of Japanese Mathematical Education.

As for the degree of difficulty, we aimed to maintain an average score of around 60 points.

2. Math I has three sections that were required of all students; in Math II the student has a choice of two of the three sections. We made sure that we gave problems in diverse areas.

3. Students' Group Divisions and Performance

For this year's exam, there were 353,010 students who took Math A with an average score of 73.37. There were 327,543 students who took Math B; of those, 52 took engineering math and 457 took business mathematics. 327,034 students took Math II, with an average score of 64.27. For each of the three sections in Math II, the number of participants who selected the problem and the average scores are shown in the following table:

Section	1	2	3
Number of Participants	301,190	263,030	89,832
Average (50 Points)	36.11	27.96	31.03

4. Content and Intent of Math I, Math II Exam Problems, and Exam Results

The content of the problems was as follows:

Mathematics I

Section 1. Second-degree equations, necessary and sufficient conditions

Section 2. Parabolas

Section 3. Trigonometric ratios

Mathematics II

Section 1. Vectors

Section 2. Differentiation, integration, sequences [progressions]

Section 3. Probability

The intent of each problem was as follows:

Mathematics I

Section 1

1. Determine the student's understanding regarding the quotient and the remainder of second-degree polynomials with integer coefficients.

2. Determine the degree of understanding regarding the logic of necessary and sufficient conditions.

Section 2

On the topic of the relationship between a parabola and a line, determine knowledge of the basic facts regarding second-degree functions and their graphs.

Section 3

On the topic of inscribed and circumscribed circles of a triangle, determine knowledge of basic facts regarding trigonometric ratios.

Mathematics II

Section 1

1. Determine the student's understanding of and ability to apply the basic facts regarding two-dimensional vectors.

Section 2

1. Determine the student's understanding of the basic facts related to differentiation and integration of a third-degree polynomial.

2. Test the student's thinking ability and understanding of geometric progressions using a sequence of fractions.

3. Test the student's ability to calculate the probability of a combination of given numbers.

The following indicates the percentage of correct answers, incorrect or incomplete answers, and no answers for each problem.

Mathematics I

Section 1

1. One would know how to solve this basic remainder theorem problem by factoring three second-degree expressions. The percentage of correct answers for each part was high, above 80%.

2. This problem tests the theoretical thought process involving necessary and sufficient conditions. $\{\underline{16}\}$ can be solved by looking at the graph. The percentage of correct answers was high: 81.38%. However, the percentage of correct answers on other parts were unexpectedly low (57.4% for $\{\underline{14}\}$, 60.48% for $\{\underline{15}\}$, 49.22% for $\{\underline{17}\}$); perhaps students were not used to finding counterexamples.

Section 2

This section tests basic understanding and application ability related to second-degree curves. The percentage of correct answers for Part 1 was 85%. Though overall performance was good, we think the students were not used to eliminating parameters. Part 2 investigates the situation when a parabola and a line intersect. With the exception of the last inequality, the percentage of correct answers was above 85%, an impressive performance. The average for Section 2 was 27.84 (out of 35 points), the best among the three sections.

Section 3

This is a standard problem involving two-dimensional graphs, expressions, and trigonometric ratios. The scoring rate was about 67%. In Part 1 the problem is to find the center and the radius of $\triangle ABC$'s circumscribed circle and to find the radius of the inscribed circle. A surprisingly low percentage, 59%, of the students were able to find the center of the circumscribed circle.

We think that the great difference between the percentage of correct answers for finding the area of $\triangle ABC$ (76%) and the percentage of correct answers for finding the radius of the inscribed circle (about 55%) was because some participants did not know the formula $S = rs$. Part 2 asked for the maximum and minimum values of the distance between the origin and a point P moving along the edges of the $\triangle ABC$. When the question was given, we were concerned with whether or not the students knew the formula for the distance between a point and the line, but the results indicate that the difficulty level of this question was not a problem.

Mathematics II

Section 1

This section tests the basics and applications of vectors using two-dimensional graphs. The selection rate was 92%, and the average was 36.11.

1. Calculate a position vector and its magnitude. The percentage of correct answers was high, about 75%.

2. This part tests the application of the law of cosines for triangles and the ability to find the position vector of an interior point and the ratio of the magnitudes of vectors. The percentage of correct answers moved downward from 90% to 45% in this part.

Section 2

1. (1) Find the function from its minimum value and then find its maximum value.
(2) Bound the slope of the tangent, and find the range of the angle formed by the tangent and the positive x-axis.
(3) Find the volume of a solid of revolution. It is a standard integration problem. The scoring rate of Part 1 was 75%.

2. (1) This problem is to note the pattern of the sequence. It is useful to express the number of terms using a geometric progression and note that $2^9 = 512 < 1000 < 2^{10} = 1024$.
(2) This problem asks one to consider the converse. It was devised to test the student's thinking and application abilities. The percentage of correct answers was unexpectedly low (26% for the first part and 14.7% for the second part) and many left this problem blank.

Section 3

Find the probability of picking three cards out of 9 cards. Parts 1, 2, 3, and 4 were basic, and the percentage of correct answers ranged from 63% to 87%. Well done. Because Part 5 used the letter k, there were many wrong answers and blank answers; the percentage of correct answers was cut down to 30%. The overall average of Section 3 was 31.03 (out of 50 points possible), which is considered high for a probability problem.

5. Analysis of Criticism and Opinions on Exam Problems

(1) Overall this year's exam problems were found to be basic, and suitable to test the achievement level of learning steps in the senior high schools.
(2) On this year's Math II, the problem on sequences in Section 2, Part 2 was good; others said it was beyond the scope of the textbooks of the senior high schools. It is regrettable but, because of the limit on the number of blanks, we could not set the question up in steps.
(3) In the make-up exam for Math II, Section 1, one of the angles was expressed in radians. According to the guidelines of the UECE, it should have been in degrees. The students were not confused, but we should be more cautious in constructing problems in the future.

6. The Make-up Exam

The number of participants in this year's make-up exam was 201 for Math I and 191 for Math II. The content of Math I problems was as follows:

Section 1. The least common multiple and the largest common factor of two third-degree polynomials with integer coefficients;

Section 2. Parabolas;

Section 3. Trigonometric ratios and the circle on the two-dimensional coordinate plane.

The content of Math II problems was as follows:

Section 1. Vectors;

Section 2. Sequences, trigonometric functions, third-degree functions;

Section 3. Probability.

Examinees were to choose two sections from the above three. After adjusting the degree of difficulty of the original exam, this year's make-up exam was considered adequate on the whole; however, it seemed that the problem on probability was somewhat difficult.

7. Points to be Considered in Constructing Problems in the Future

(1) We should take care not to go beyond the range of the guidelines for the senior high school studies. For those problems requiring a high level of thinking, we should consider whether or not questions should be asked in stages.

(2) Regarding the necessary-sufficient condition problem or any theorem-proof type problem, some judged that it could not be expected to test thinking ability. We should put more effort toward avoiding those problems which many students can answer without understanding the content.

(3) Following the basic guidelines stated in 1 and being careful to avoid wide variations in the degree of difficulty in the optional problem sections, we would like to maintain the 60% average score in the future.

Survey of University Entrance Center Examination*

(Division of Research, Senior High Schools Division Association, Association of Japanese Mathematical Education)

Please circle the suitable choices among [1] through [21] in the following and enter the appropriate number in the blank for question 6.

Your field of study:
- [1] science, engineering, medicine, pharmacology, agriculture
- [2] other

1. Your exam subject:
   - [3] Math I only
   - [4] Math I and Math II
2. Compared to the section and chapter review problems of the textbooks, overall, the exam problems on Math I were
   - [5] easier
   - [6] about the same level
   - [7] harder

   and on Math II were
   - [8] easier
   - [9] about the same level
   - [10] harder
3. Level of the problems:
   - [11] it was sufficient to study the important points of the textbooks
   - [12] it was necessary to prepare for the exam
4. Number of problems on Math I:
   - [13] too few
   - [14] just right
   - [15] too many

   Number of problems on Math II:
   - [16] too few
   - [17] just right
   - [18] too many
5. Problems you solved in Math II:
   - [19] [Algebra, Geometry] and [Basic Analysis]
   - [20] [Algebra, Geometry] and [Probability, Statistics]
   - [21] [Basic Analysis] and [Probability, Statistics]
6. Which problem in Math I did you find the most difficult? Problem number ____ .

* The 1990 UECE was held on January 13, 14 (the make-up exam on January 20, 21). This survey was made on February 8, 1990 among those seniors who were expecting to graduate in March 1990 from 31 national and local public high schools in the Tokyo metropolitan area.

RESULTS OF SURVEY ON UNIVERSITY ENTRANCE CENTER EXAMINATION

February 8, 1990

	SCIENCE MAJORS		HUMANITIES MAJORS		SCIENCE & HUMANITIES MAJORS	
Response	Number of Responses	Percentage of Responses	Number of Responses	Percentage of Responses	Number of Responses	Percentage of Responses
[3]	42	4.34	144	20.90	186	11.23
[4]	926	95.66	545	79.10	1,471	88.77
[5]	293	30.49	166	23.65	459	27.60
[6]	478	49.74	375	53.42	853	51.29
[7]	190	19.77	161	22.93	351	21.11
[8]	178	19.45	77	13.73	255	17.28
[9]	449	49.07	266	47.42	715	48.44
[10]	288	31.48	218	38.86	506	34.28
[11]	512	54.07	350	51.09	862	52.82
[12]	435	45.93	335	48.91	770	47.18
[13]	30	3.11	13	1.92	43	2.62
[14]	732	75.93	497	73.52	1,229	74.94
[15]	202	20.95	166	24.56	368	22.44
[16]	33	3.60	22	3.87	55	3.71
[17]	622	67.90	363	63.91	985	66.37
[18]	261	28.49	183	32.22	444	29.92
[19]	570	61.36	324	57.65	894	59.96
[20]	207	22.28	167	29.72	374	25.08
[21]	152	16.36	71	12.63	223	14.96

Survey sample of 31 schools.

Conclusion

The translations of the evaluation of the UECE and the analysis of the exam parts in the previous pages may seem repetitious at times, but they are intended to show Japanese mathematics educators' expectations of high school mathematics as well as the students' level of performance. As was stated in the introduction, one of the goals of the UECE Committee is to encourage more private universities to make use of the UECE in their selection of students. Because of the large number of applicants to all universities and because the function of the UECE is to test the basic material covered in the standard high school curriculum, many public and those private universities participating in the UECE will continue, at least in the near future, to use the UECE as a screening device to be followed by their own individual university examinations. The cram schools, Juku and Yobiko,* will also continue to serve the needs of the applicants.

For the purposes of comparison, sample 1991 university examinations from Tokyo University, Hokkaido University, Shiga University, and Shiga Medical University are included in the Appendix.

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APPENDIX I

INDIVIDUAL UNIVERSITY EXAMINATIONS

The number of exam takers and the number of those who passed are provided for each examination. Among these four national universities, Tokyo University is recognized as having the highest ranking followed by Hokkaido University and then Shiga University and Shiga Medical University. Because of the exam calendar, a student can take at most two national university examinations. It is indeed crucial for applicants to make a careful personal assessment in order to target their application to an appropriate university. Often, the ratio of the number of applicants to the number accepted for a very difficult university may actually be smaller than that for a less difficult university which is a popular target.

The subjects referred to on the top of each examination are those covered in Japanese high school mathematics. The following is a brief description of each subject. For detailed topics in each subject, please see Fujita's paper.

Math I College algebra and a portion of trigonometry involving sine, cosine, and tangent, the law of sines, the law of cosines.

Math II Permutations, combinations, probability, statistics, vectors, differentiation and integration, sequences, exponential, logarithmic, and trigonometric functions, functions of electronic computers, algorithms, and flow charts.

Algebra/Geometry Conic sections, vectors in two and three dimensions, matrices.

Basic Analysis Sequences, mathematical induction, exponential, logarithmic, and trigonometric functions, derivatives and applications, integrals and applications.

Differentiation and Integration

Probability and Statistics

TOKYO UNIVERSITY

Examination A
Science

Date: February 25, 1991
Time: 150 minutes
Subjects: Math I, Algebra/Geometry, Basic Analysis, Calculus, Probability/Statistics
Number of exam takers: 2714
Number of those accepted: 1183
For the second stage exam, 139 out of 584 were accepted.

1. Given a regular pyramid with a triangular base set in a two-dimensional plane, select any edge of the three sides of the face touching the plane and use the edge as an axis to turn over the pyramid. Find the probability that, after repeating this action n times, the original face is again touching the plane.

2. Let a, b, and c be positive real numbers. In the xyz-space, consider the plane R consisting of points (x, y, z) satisfying the conditions

$$|x| \leq a, \quad |y| \leq b, \quad z = c.$$

Let P be the source of light on the plane

$$z = c + 1$$

moving along the ellipse

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, \qquad z = c + 1$$

once around. Sketch and calculate the area of the shadow projected by the plane R on the xy-plane.

3. Let p be a constant. Consider the third-degree equation

$$x^3 - 3x - p = 0.$$

Let $f(p)$ be the product of the largest real root and the smallest real root. In case there is only one real root, $f(p)$ is defined as the square of that root.

(1) Find the minimum value of $f(p)$ for all p.

(2) Sketch the graph of $f(p)$ as a function of p.

4. (1) For natural numbers $n = 1, 2, \ldots$, prove that there exist polynomials $p_n(x)$, $q_n(x)$, such that

$$\sin n\theta = p_n(\tan\theta)\cos^n\theta,$$

$$\cos n\theta = q_n(\tan\theta)\cos^n\theta.$$

(2) Then, for $n > 1$, prove that one can establish the following identities:

$$p'_n(x) = nq_{n-1}(x),$$

$$q'_n(x) = -np_{n-1}(x).$$

5. On the xy-plane, a point (m, n), with m, n integers, is called a lattice point. Using each lattice point as a center, draw a circle of radius r. Any line with slope 2/5 intersects some of these circles. Find the minimum value of real numbers r having this property.

6. Let $f(x)$ be a continuous function defined for $x > 0$ such that $f(x_1) > f(x_2) > 0$ whenever $0 < x_1 < x_2$. Let

$$S(x) = \int_x^{2x} f(t)\,dt$$

and $S(1) = 1$. For any $a > 0$, the area bounded by the following is $3S(a)$:

(a) the line joining the origin and the point $(a, f(a))$;
(b) the line joining the origin and the point $(2a, f(2a))$;
(c) the curve $y = f(x)$.

(1) Express $S(x)$, $f(x) - 2f(2x)$ as a function of x.

(2) For $x > 0$, let

$$a(x) = \lim_{n\to\infty} 2^n f(2^n x).$$

Find the value of the integral

$$\int_x^{2x} a(t)\,dt.$$

(3) Determine the function $f(x)$.

Examination B
Humanities

Date: February 25, 1991
Time: 100 minutes
Subject: Math I, Algebra/Geometry, Basic Analysis
Number of exam takers: 1906
Number of those accepted: 642
For the second stage exam, 74 out of 331 were accepted.

1. Find the maximum and minimum values of

$$f(x) = x^3 - 2x^2 - 3x + 4$$

over the interval

$$-\frac{7}{4} \leq x \leq 3.$$

2. Consider the point P $(2, 0, 1)$ in xyz-space and the curve

$$z = y^2$$

in the yz-plane. As point Q moves along this curve, let R be the point of intersection of the line PQ (extended) and the xy-plane. Letting F be the graph of the set of points R, draw F in the xy-plane.

3. A rectangle $ABCD$ has side lengths 1 and a. Point E is the point of intersection of the two diagonals. Draw five circles centered at A, B, C, D, and E, each with radius r. Maximize r in such a way that the intersection of any two circles is empty. Let $S(a)$ be the total area of the five circles cut by the rectangle. Sketch the graph of

$$\frac{s(a)}{a}$$

as a function of a.

4. Given a regular pyramid V with a square base, there is a ball with its center on the bottom of the pyramid and tangent to all edges. If each edge of the pyramid base is a, find the following quantities:

(1) the height of V;

(2) the volume of the portion common to the ball and the pyramid.

Note: A regular pyramid has a square base adjoined to four isosceles triangles, with each edge of the square making up the base of one of the triangles.

HOKKAIDO UNIVERSITY

Examination A
Science I, Pre-medical and Pre-dental Applicants

Date: February 25, 1991
Time: 120 minutes
Subjects: Math I, Algebra/Geometry, Basic Analysis, Differential and Integral Calculus, Probability/Statistics
Number of exam takers: 1641
Number of those accepted: 636
For the second stage exam, 133 out of 838 were accepted.

1. Let α, β be two solutions of the second-degree equation in x:

$$x^2 - 2px + p^2 - 2p - 1 = 0.$$

Find a real value p such that

$$\frac{1}{2}\frac{(\alpha-\beta)^2 - 2}{(\alpha+\beta)^2 + 2}$$

is an integer.

2. For a real number t, let

$$x(t) = \frac{2^t + 2^{-t}}{2},$$
$$y(t) = \frac{2^t - 2^{-t}}{2}.$$

Let $M(t)$ be the centroid of the triangle whose vertices are $[x(t), y(t)]$, $[x(t+1), y(t+1)]$, and $[x(t+2), y(t+2)]$. Find the locus of $M(t)$ as t varies through all real numbers.

3. Given the curve $C: y = f(x)$, suppose that the tangent line at $P(x, y)$ is perpendicular to the line segment joining P and $Q(1, 0)$.

(1) Find a differential equation satisfied by $y = f(x)$.

(2) If $y = (-2/3)x + 5$ is tangent to the curve C, find the equation for the curve C.

4. Answer the following:

(1) Show that

$$\lim_{n\to\infty} \frac{1}{n}\left\{\sum_{k=n+1}^{2n} \log k - n\log n\right\} = \int_1^2 \log x\,dx.$$

(2) Find

$$\lim_{n\to\infty}\left(\frac{(2n)!}{n!n^n}\right)^{1/n}.$$

5. Given three points $O\ (0,0,0)$, $A\ (\sqrt{2},0,0)$, and $B\ (0,\sqrt{2},0)$ and a sphere of radius $\sqrt{6}$ in xyz-space. The center of the sphere has a positive z-coordinate and the sphere is tangent to OA, OB, and AB.

(1) Find the coordinates of the center of the sphere.

(2) Find the volume of the portion of the sphere which is above the xy-plane.

Examination B
Science II, Science III and Fishery Applicants

Date: February 25, 1991
Time: 120 minutes
Subjects: Math I, Algebra/Geometry, Basic Analysis, Differential and Integral Calculus, Probability/Statistics
Number of exam takers: 2030
Number of those accepted: 764

1. Let α, β be two solutions of the second-degree equation in x:

$$x^2 - 2px + p^2 - 2p - 1 = 0.$$

Find a real value p such that

$$\frac{1}{2}\frac{(\alpha-\beta)^2 - 2}{(\alpha+\beta)^2 + 2}$$

is an integer.

2. Given three points on the plane $O\ (0,0)$, $A\ (1,0)$, and $B\ (-1,0)$, point P is moving on the plane satisfying the condition

$$\left(\overrightarrow{PA}, \overrightarrow{PB}\right) + 3\left(\overrightarrow{OA}, \overrightarrow{OB}\right) = 0.$$

(1) Find the locus of P.

(2) Find the maximum and minimum values of

$$|\overrightarrow{PA}| \cdot |\overrightarrow{PB}|.$$

3. Let $\triangle ABC$ be a triangle with $\angle A = 120°$, $AB \cdot AC = 1$. Let D be the intersecting point of BC and the bisector of $\angle A$.

(1) If $AB = x$, express AD in terms of x.

(2) If x is a variable, find x such that AD is the maximum. Also find this maximum value.

4. Answer the following:

(1) Show that

$$\lim_{n\to\infty} \frac{1}{n}\left\{\sum_{k=n+1}^{2n} \log k - n\log n\right\} = \int_1^2 \log x\,dx.$$

(2) Find

$$\lim_{n\to\infty}\left(\frac{(2n)!}{n!n^n}\right)^{1/n}.$$

5. Given three points $O\ (0,0,0)$, $A\ (3,0,0)$, $B\ (0,4,0)$, and a sphere of radius 2 in xyz-space. The center of the sphere has a positive z-coordinate and the three line segments OA, OB, and AB are tangent to the sphere. Find the coordinates of the center of the sphere.

Examination C
Humanities Applicants

Date: February 25, 1991
Time: 90 minutes
Subjects: Math I, Algebra/Geometry, Basic Analysis
Number of exam takers: 1953
Number of those accepted: 508
For the second stage exam, 69 out of 675 were accepted.

1. Let α, β be two solutions of the second-degree equation in x:

$$x^2 - 2px + p^2 - 2p - 1 = 0.$$

Find a real value p such that

$$\frac{1}{2}\frac{(\alpha-\beta)^2 - 2}{(\alpha+\beta)^2 + 2}$$

is an integer.

2. Given three points on the plane O $(0,0)$, A $(1,0)$, and B $(-1,0)$, point P is moving on the plane satisfying the condition

$$\left(\overrightarrow{PA},\overrightarrow{PB}\right) + 3\left(\overrightarrow{OA},\overrightarrow{OB}\right) = 0.$$

(1) Find the locus of P.
(2) Find the maximum and minimum values of

$$|\overrightarrow{PA}|\cdot|\overrightarrow{PB}|.$$

3. n is a natural number greater than 2. Use mathematical induction to prove the inequality

$$\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{3}} + \cdots + \frac{1}{\sqrt{n}} < 2\sqrt{n} - 2.$$

4. Suppose $f(x)$ is a linear function of x. Let

$$F(x) = x\int_1^{2x+3} f(t)\,dt.$$

Determine $f(x)$ if $F(1) = 2$, $F'(0) = -10$.

SHIGA UNIVERSITY

Examination A
Education Division: Elementary, Secondary, Information Sciences

Date: February 25, 1991
Time: 90 minutes
Subjects: Math I, Algebra, Geometry, Basic Analysis
Number of exam takers: 1438
Number of those accepted: 388

1. Let α, β be two solutions of the second-degree equation

$$x^2 - px + 1 = 0.$$

Let α', β' be two solutions of the second-degree equation

$$x^2 - x + q = 0.$$

Express

$$(\alpha'-\alpha)(\alpha'-\beta)(\beta'-\alpha)(\beta'-\beta)$$

in terms of p, q.

2. Let

$$A = \begin{pmatrix} 1 & -1 \\ 2 & 3 \end{pmatrix}, \qquad B = \begin{pmatrix} a & b \\ 1 & -2 \end{pmatrix}.$$

If $(A+B)^2 = A^2 + 2AB + B^2$, determine the values of a and b.

3. Graph the region bounded by the simultaneous inequalities

$$x - 2y^2 \geq 0$$

$$1 - x - |y| \geq 0.$$

Find the area of this region.

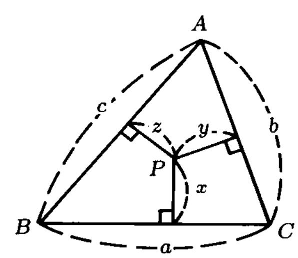
4. Sequence $\{a_n\}$ satisfies

$$a_1 + 2a_2 + 3a_3 + \cdots + na_n = \frac{n+1}{n+2} \quad (n \geq 1).$$

Find the sum

$$S_n = a_1 + a_2 + a_3 + \cdots + a_n.$$

5. Let a, b, c be the sides of $\triangle ABC$ and S be the area. From an interior point P, draw the line perpendicular to each side with lengths x, y, and z, respectively, as is shown below:



(1) Express S in terms of a, b, c, x, y, and z.
(2) Let $P'(x,y,z)$ be a point corresponding to point P. Prove that as P moves within $\triangle ABC$, the graph of $P'(x,y,z)$ describes a triangle.
(3) Prove that if P is the center of gravity of $\triangle ABC$, then P' is also the center of gravity of the triangle obtained in (2).

Examination B
Economics Division

Date: March 5, 1991
Time: 100 minutes
Subject: Math I, Algebra/Geometry, Basic Analysis
Number of exam takers: 2803
Number of those accepted: 686

1. Consider the graphs of the function

$$y = \sqrt{2x-1}$$

and the straight line $y = x + k$.

Discuss the number of points of intersection versus the change in the value of k.

2. In $\triangle ABC$, Q is a point on AC such that $AQ : QC = 3 : 4$. P is a point on BQ such that $BP : PQ = 7 : 2$. Let O be any point. Answer the following questions.

(1) Express

$$\overrightarrow{OQ} = \alpha\overrightarrow{OA} + \beta\overrightarrow{OC},$$

where α and β are rational numbers.

(2) Express

$$\overrightarrow{OP} = l\overrightarrow{OA} + m\overrightarrow{OB} + n\overrightarrow{OC}.$$

where l, m, and n are rational numbers.

3. Let $\angle C$ be the 90° angle in the right triangle ABC. Set the hypotenuse AB equal to a.

(1) If D is the point of tangency of the inscribed circle and the hypotenuse AB, prove that

$$AD = \frac{1}{2}(AB + AC - BC).$$

(2) If θ is $\frac{1}{2}\angle A$, express the radius r of the inscribed circle in terms of a and θ.

(3) Find the maximum value of r.

4. For each x, let $f(x)$ be equal to the smaller of the two values $(x-a)^2$ and $(x-a-2)^2$. Let

$$F(a) = \int_0^1 f(x)\,dx.$$

Find the maximum and the minimum of $F(a)$ with $-2 \le a \le 2$.

SHIGA MEDICAL UNIVERSITY

Medical School Examination

Date: March 5, 1991
Time: 120 minutes
Subject: Math I, Algebra/Geometry, Basic Analysis, Calculus
Number of exam takers: 531
Number of those accepted: 140

1. (1) Given $a^2 \ge b$, where a, b are natural numbers, prove that the necessary and sufficient condition for

$$\sqrt{a+\sqrt{b}} + \sqrt{a-\sqrt{b}}$$

to be a natural number is that there exists a natural number n such that

$$n^2 < a \le 2n^2 \quad \text{and} \quad b = 4n^2(a-n^2)$$

(2) Find all values of natural numbers b such that

$$\sqrt{30+\sqrt{b}} + \sqrt{30-\sqrt{b}}$$

is a natural number.

2. $\triangle ABC$ varies with time t. Suppose in $\triangle ABC$, $\angle A$ is an acute angle θ and the area is fixed. Let the lengths of the three sides be $a = BC$, $b = CA$, and $c = AB$.

(1) Express the rate of change of θ with respect to t

$$\frac{d\theta}{dt}$$

in terms of

$$b,\ c,\ \frac{db}{dt},\ \frac{dc}{dt},\ \text{and } \theta.$$

(2) Express the rate of change of a with respect to t

$$\frac{da}{dt}$$

in terms of

$$b,\ c,\ \frac{db}{dt},\ \frac{dc}{dt},\ \text{and } \theta.$$

(3) Suppose $\triangle ABC$ is an equilateral triangle with each side equal to 10 and

$$\frac{db}{dt} = 2, \qquad \frac{dc}{dt} = -1.$$

Find the rate of change for θ and for a with respect to t.

3. Let AB be a line segment of 1 unit length moving in such a way that A $(s, 0)$ with $0 \le s \le 1$ is a point on the x-axis and B $(0, t)$ with $0 \le t \le 1$ is a point on the y-axis.

(1) Express in terms of s and x_0 the y-coordinate of the point of intersection of AB and the line $x = x_0$ where $0 \le x_0 \le s$.

(2) Use the inequalities to express the interval of possible values of x and the interval of possible values of y where (x, y) is a point on AB.

4. Let l be the line of intersection of two planes:

$$\Pi_1\colon ax + y + z = a$$

$$\Pi_2\colon x - ay + az = -1.$$

(1) Find a direction vector of the line l.

(2) The line l describes a surface as the real number a varies. Let (x, y) be the point of intersection of the surface and the plane $z = t$. Find an equation which gives the relation between x and y.

(3) Find the volume bounded by the two planes, $x = 0$ and $x = 1$, and the surface obtained in (2) as t varies.

APPENDIX II

SOLUTIONS TO TOKYO UNIVERSITY EXAMS

Examination A Science

1. For $n = 0, 1, 2, \ldots$, define

$$P_n = \text{the probability of having the first face touching the plane after } n \text{ operations.}$$

The sequence $\{P_n\}$ satisfies the recursive relation:

$$P_{n+1} = (1 - P_n) \times \frac{1}{3}$$

This can be written as

$$P_{n+1} - \frac{1}{4} = -\frac{1}{3}\left(P_n - \frac{1}{4}\right).$$

That is, $\{P_n - \frac{1}{4}\}$ is a geometric progression with the ratio $-\frac{1}{3}$:

$$P_n - \frac{1}{4} = \left(-\frac{1}{3}\right)^n \left(P_0 - \frac{1}{4}\right).$$

From the definition of P_n, $P_0 = 1$. Therefore,

$$P_n = \frac{1}{4} + \frac{3}{4}\left(-\frac{1}{3}\right)^n.$$

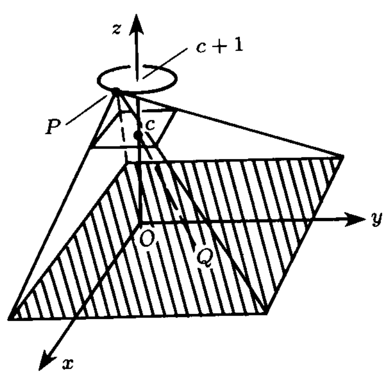
2. We shall rescale the x-axis by $1/a$ times, and the y-axis by $1/b$ times so that we first consider the case with the plane

$$R: |x| \le 1,\ |y| \le 1,\ z = c$$

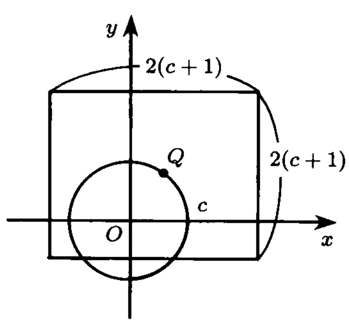
and the source light is moving along the circle

$$x^2 + y^2 = 1, \quad z = c + 1.$$

Then we adjust accordingly afterwards.

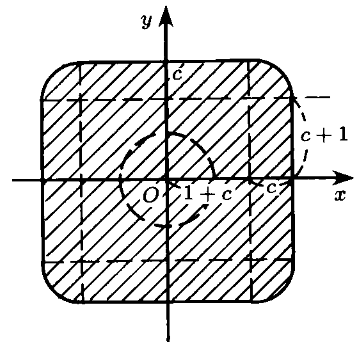


First let us fix the point $P(\alpha, \beta, c+1)$. The image of R on the xy-plane is a rectangle enlarging R by $(c+1)$ times with the center $Q(-c\alpha, -c\beta, 0)$ which is the corresponding image of P on the xy-plane.



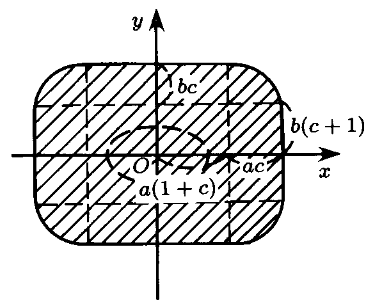
Next as P moves along the circle, Q moves along the circle $x^2 + y^2 = c^2$ on the xy-plane.

The area covered by the squares of $2(c+1)$ by $2(c+1)$ with a center on $x^2 + y^2 = c^2$ is $\pi c^2 + 8c(c+1) + 4(c+1)^2$.



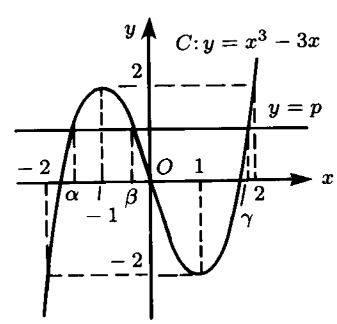
Adjusting to the case of the ellipse, the required area is

$$ab[(\pi + 12)c^2 + 16c + 4].$$



3. (1) From the graph of $y = x^3 - 3x$, the number of real roots is

$$\begin{cases} 3 & \text{when } |p| \le 2, \\ 1 & \text{when } |p| > 2. \end{cases}$$

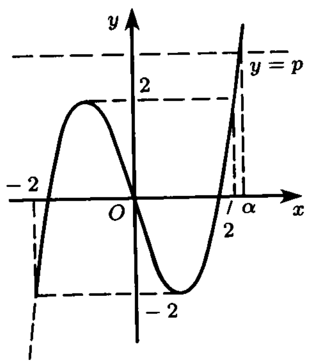


Case (i) $|p| \le 2$.

Let α, β, γ be three real roots with $\alpha \le \beta \le \gamma$. Then $f(p) = \alpha\gamma$. From the relationship between the roots and coefficients of a polynomial equation, $\alpha\beta\gamma = p$, and we have

$$f(p) = \frac{p}{\beta} = \frac{\beta^3 - 3\beta}{\beta} = \beta^2 - 3$$

with $-1 \le \beta \le 1$.



The minimum value of $f(p)$ for $|p| \leq 2$ is when $\beta = 0$. That is, the minimum value is -3 when $p = 0$.

Case (ii) $|p| > 2$.

Let α be the single real root. Then

$$f(p) = \alpha^2.$$

Since $\alpha < -2$ or $\alpha > 2$, $f(p) > 4$. Therefore, the minimum value of $f(p)$ is -3.

(2) Use the same symbols as in (1).

Case (i) $|p| < 2$.

As p increases, β decreases from 1 to -1 and $f(p) = \beta^2 - 3$ varies as indicated in the chart below.

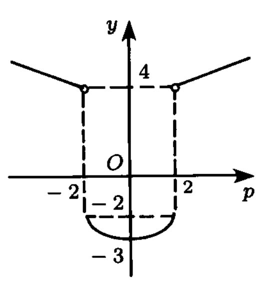
p	-2		0		2
β	1	↘	0	↘	-1
$f(p)$	-2	↘	-3	↗	-2

Case (ii) $|p| > 2$.

As p increases, $|\alpha|$ increases and $f(p) = \alpha^2$ varies as indicated in the chart below.

p	$-\infty$		-2		2		
α	$-\infty$	↗	-2	╳	2	↗	∞
$f(p)$	$-\infty$	↘	4	╳	4	↗	∞

The following is a rough sketch of the graph of $f(p)$.



4. (1) Proof by mathematical induction.

First note that

$$\begin{cases} \sin\theta = \tan\theta \cdot \cos\theta \\ \cos\theta = 1 \cdot \cos\theta \end{cases}$$

so for $n = 1$, take $p_1(x) = x$, and $q_1 = 1$.

For $n \geq 2$ suppose there are polynomials $p_{n-1}(x)$, q_{n-1} such that

$$\sin(n-1)\theta = p_{n-1}(\tan\theta)\cos^{n-1}\theta$$

$$\cos(n-1)\theta = q_{n-1}(\tan\theta)\cos^{n-1}\theta$$

From the addition formula, we have

$$\begin{aligned} \sin n\theta &= \sin(n-1)\theta\cos\theta + \cos(n-1)\theta\sin\theta \\ &= p_{n-1}(\tan\theta)\cos^n\theta + q_{n-1}(\tan\theta)\cos^n\theta\tan\theta \\ \cos n\theta &= \cos(n-1)\theta\cos\theta - \sin(n-1)\theta\sin\theta \\ &= q_{n-1}(\tan\theta)\cos^n\theta - p_{n-1}(\tan\theta)\cos^n\theta\tan\theta \end{aligned}$$

therefore, polynomials $p_n(x)$ and $q_n(x)$ are

$$\left.\begin{aligned} p_n(x) &= p_{n-1}(x) + xq_{n-1}(x) \\ q_n(x) &= q_{n-1}(x) - xp_{n-1}(x) \end{aligned}\right\} \quad (1)$$

and

$$\sin n\theta = p_n(\tan\theta)\cos^n\theta$$

$$\cos n\theta = q_n(\tan\theta)\cos^n\theta$$

(2) Proof by induction also.

First note that

$$\begin{cases} p_1(x) = x, & q_1(x) = 1 \\ p_2(x) = 2x, & q_2(x) = 1 - x^2 \end{cases}$$

which establishes the required identity for $n = 2$.

For $n > 2$, suppose (2) holds for $m - 1$, i.e.,

$$p'_{m-1}(x) = (m-1)q_{m-2}(x)$$

$$q'_{m-1}(x) = -(m-1)p_{m-2}(x)$$

From equation (1) above

$$\begin{aligned} p'_m(x) &= p'_{m-1}(x) + xq'_{m-1}(x) + q_{m-1}(x) \\ &= (m-1)\{q_{m-2}(x) - xp_{m-2}(x)\} + q_{m-1}(x) \\ &= (m-1)q_{m-1}(x) + q_{m-1}(x) \\ &= mq_{m-1}(x) \\ q'_m(x) &= q'_{m-1}(x) - xp'_{m-1}(x) - p_{m-1}(x) \\ &= -(m-1)p_{m-2}(x) - (m-1)xq_{m-2}(x) - p_{m-1}(x) \\ &= -(m-1)\{p_{m-2}(x) + xq_{m-2}(x)\} - p_{m-1}(x) \\ &= -(m-1) \cdot p_{m-1}(x) - p_{m-1}(x) \\ &= -mp_{m-1}(x). \end{aligned}$$

This establishes (2) for $n = m$.

5. A line with the slope $\frac{2}{5}$ can be expressed as

$$2x - 5y - k = 0 \quad (k \text{ a constant})$$

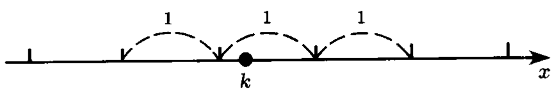
This line and the circle with radius r and center at (m, n) will have a common point if

$$\frac{|2m - 5n - k|}{\sqrt{2^2 + (-5)^2}} \leq r,$$

i.e.,

$$|2m - 5n - k| \leq \sqrt{29}r. \quad (1)$$

Therefore, we should look for a condition on r to guarantee that given any real number k, there is a pair of whole numbers m, n such that (1) is true. As the pair m, n varies, $2m-5n$ varies through all integers. In fact for any integer N, $N = 2 \cdot (3N) - 5 \cdot N$. Thus the above condition is equivalent to "for any real number k, there is an integer N such that $|N-k| \le \sqrt{29}r$." That is, "On the real line, for any real number k, there is an integral point N such that the distance between the point k and the point N is less than or equal to $\sqrt{29}r$."



Since the integral points on the real line are 1 unit apart, it follows that $\sqrt{29}r \ge \frac{1}{2}$, i.e.,

$$r \ge \frac{1}{2\sqrt{29}} = \frac{\sqrt{29}}{58}.$$

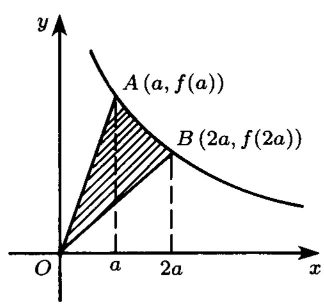
Therefore, the minimum value of r is $\sqrt{29}/58$.

6. (1)

Area bounded by OA, OB, and $f(x)$

$$= 3S(a)$$
$$= \frac{1}{2}a \cdot f(a) + S(a) - \frac{1}{2} \cdot 2a \cdot f(a).$$

$\therefore S(a) = \frac{1}{4}(a \cdot f(a) - 2a \cdot f(2a))$ for any $a > 0$.



Replacing a by x:

$$S(x) = \frac{1}{4}\left(x\,f(x) - 2x\,f(2x)\right). \qquad (1)$$

On the other hand, differentiating

$$S(x) = \int_x^{2x} f(t)\,dt,$$

we have

$$S'(x) = 2f(2x) - f(x). \qquad (2)$$

From (1) and (2), we have a differential equation

$$xS'(x) = -4S(x) \quad x > 0.$$

Solving with the initial condition $S(1) = 1$, we have

$$S(x) = \frac{1}{x^4}. \qquad (3) \text{ answer}$$

Also (2) and (3) together give

$$f(x) - 2f(2x) = \frac{4}{x^5}. \qquad (4) \text{ answer}$$

(2) From (4) above, given any $t > 0$ and any integer k

$$f(2^k t) - 2f(2^{k+1}t) = \frac{4}{(2^k t)^5}.$$

$$\therefore 2^k f(2^k t) - 2^{k+1} f(2^{k+1}t) = \frac{4}{2^{4k} t^5}.$$

Summing the above equations for $k = 0, 1, 2, \ldots, n-1$, we have

$$\sum_{k=0}^{n-1} \{2^k f(2^k t) - 2^{k+1} f(2^{k+1}t)\} = \frac{4}{t^5} \sum_{k=0}^{n-1} \frac{1}{2^{4k}}$$

and hence

$$f(t) - 2^n f(2^n t) = \frac{4}{t^5} \frac{1 - \frac{1}{16^n}}{1 - \frac{1}{16}}.$$

As $n \to \infty$, we see that

$$f(t) - a(t) \to \frac{64}{15} \frac{1}{t^5}. \qquad (5)$$

For any $x > 0$, take the definite integral of both sides of (5) from $t = x$ to $t = 2x$,

$$S(x) - \int_x^{2x} a(t)\,dt = \frac{64}{15} \int_x^{2x} \frac{dt}{t^5}.$$

$$\therefore \int_x^{2x} a(t)\,dt = \frac{1}{x^4} - \frac{64}{15}\left[-\frac{1}{4t^4}\right]_x^{2x} = 0. \qquad \text{answer}$$

(3) From the definition of $a(x)$, $a(x) \ge 0$ for all $x > 0$. Also because $a(x)$ is continuous following (5),

$$a(x) = 0$$

for all x in order to establish the result of (2). This implies

$$f(x) = \frac{64}{15} \cdot \frac{1}{x^5}, \qquad x > 0. \qquad \text{answer}$$

Examination B
Humanities

1. $f'(x) = 3x^2 - 4x - 3$. Let $\alpha = (2 - \sqrt{13})/3$ and $\beta = (2 + \sqrt{13})/3$, then $-\frac{7}{4} < \alpha < \beta < 3$.

x	$-\frac{7}{4}$		α		β		3
$f'(x)$		+		−		+	
$f(x)$		↗		↘		↗	

Using the relation

$$f(x) = f'(x)\left(\frac{1}{3}x - \frac{2}{9}\right) - \frac{2}{9}(13x - 15)$$

we calculate

$$f(\alpha) = -\frac{2}{9}(13\alpha - 15) = \frac{38 + 26\sqrt{13}}{27}$$

$$f(\beta) = -\frac{2}{9}(13\beta - 15) = \frac{38 - 26\sqrt{13}}{27}.$$

Also,

$$f\left(-\frac{7}{4}\right) = -\frac{143}{64}, \qquad f(3) = 4$$

$$\frac{38+26\sqrt{13}}{27} > 7, \qquad \frac{38-26\sqrt{13}}{27} > -\frac{143}{64}.$$

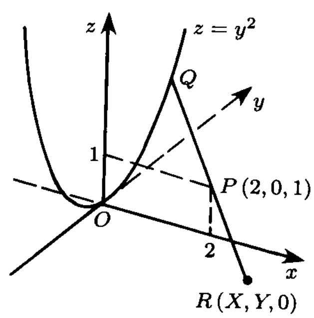
$\therefore$ The maximum value of f is

$$\max(f(\alpha), f(3)) = \frac{38+26\sqrt{13}}{27}. \qquad \text{answer}$$

The minimum value of f is

$$\min\left(f\left(-\frac{7}{4}\right), f(\beta)\right) = -\frac{143}{64}. \qquad \text{answer}$$

2. Let Q be the intersection of the line joining P and the point $R(X, Y, 0)$ on the xy-plane.



Solving the simultaneous equations

$$\begin{cases} \dfrac{x-2}{X-2} = \dfrac{y}{Y} = \dfrac{z-1}{-1}, \\ x = 0 \end{cases}$$

we have

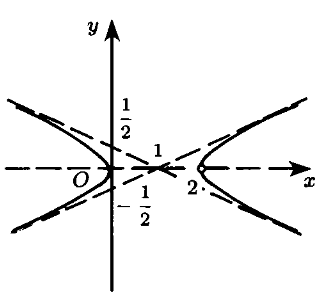
$$Q\left(0, \frac{-2Y}{X-2}, \frac{X}{X-2}\right).$$

If Q is on the parabola $z = y^2$,

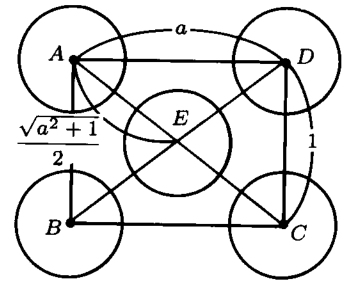
$$\frac{X}{X-2} = \left(\frac{-2Y}{X-2}\right)^2.$$

$$\therefore X(X-2) - 4Y^2 = 0 \quad \text{and} \quad X \neq 2.$$

All points $(X, Y, 0)$ satisfying the above are points of the graph of $(x-1)^2 - 4y^2 = 1$ on the xy-plane with one point $(2, 0)$ removed.

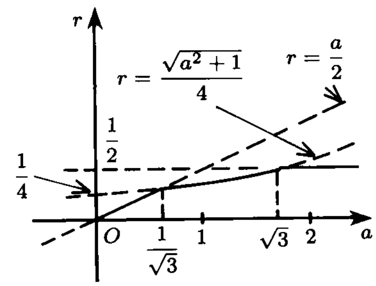


3. Let $AB = 1$, $AD = a$ in the graph below.



In order that any two circles have empty intersection, $2r \leq 1$ and $2r \leq a$. Also $2r \leq \sqrt{a^2+1}/2$. Therefore, the maximum value of r satisfying all of these conditions is

$$r = \min\left(\frac{1}{2}, \frac{a}{2}, \frac{\sqrt{1+a^2}}{4}\right)$$



(i) when $0 < a \leq \dfrac{1}{\sqrt{3}}$, $r = \dfrac{a}{2}$

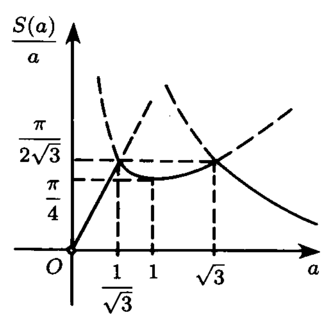
(ii) when $\dfrac{1}{\sqrt{3}} < a \leq \sqrt{3}$, $r = \dfrac{\sqrt{a^2+1}}{4}$

(iii) when $\sqrt{3} < a$, $r = \dfrac{1}{2}$

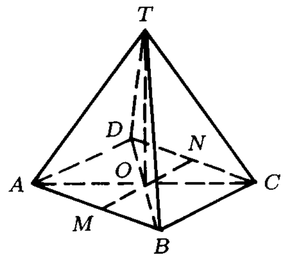
Substituting the above result in $S(a) = 2\pi r^2$, we have

$$\frac{S(a)}{a} = \begin{cases} \dfrac{\pi}{2}a, & \text{if } 0 < a \leq \dfrac{1}{\sqrt{3}} \\ \dfrac{\pi}{8} \cdot \dfrac{a^2+1}{a}, & \text{if } \dfrac{1}{\sqrt{3}} < a < \sqrt{3} \\ \dfrac{\pi}{2} \cdot \dfrac{1}{a}, & \text{if } \sqrt{3} \leq a \end{cases}$$

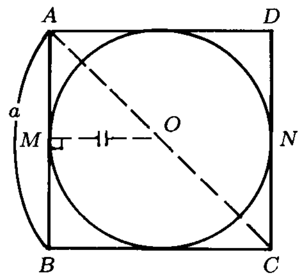
and the following graph.



4. As shown below, let T be the vertex of V and M, N be the midpoints of AB, CD, respectively.



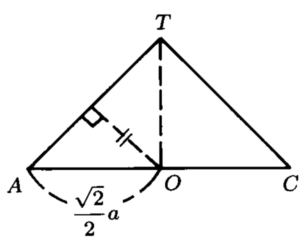
The center of the ball is on the bottom of V and the ball is tangent to four sides of the square. Therefore, the center of the ball is the center of the square and the radius is $a/2$.



Next, consider the cross section TAC. From the fact that the ball centered at O is tangent to TA and the fact that $AO = (\sqrt{2}/2)a$, we have $\angle TAO = 45°$.

$$\therefore TO = AO = \frac{\sqrt{2}}{2}a.$$

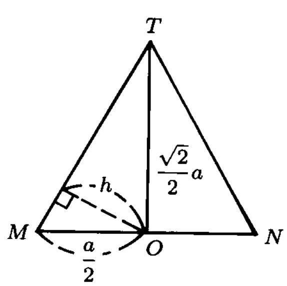
(1) It follows that the height of V is $\frac{\sqrt{2}}{2}a$.



(2) To find the volume K of that portion of the ball cut by one lateral side of V; the distance h from the center O to a lateral side of V as shown below is

$$h \cdot \sqrt{\left(\frac{a}{2}\right)^2 + \left(\frac{\sqrt{2}a}{2}\right)^2} = \frac{a}{2} \cdot \frac{\sqrt{2}}{2}a$$

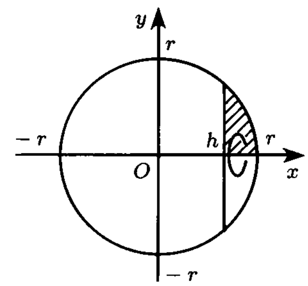
$$\therefore h = \frac{\sqrt{6}}{6}a.$$



Therefore,

$$K = \pi \int_h^{a/2} \left(\frac{a^2}{2^2} - x^2\right) dx$$

$$= \frac{1}{8}\left(\frac{2}{3} - \frac{7\sqrt{6}}{27}\right)\pi a^3.$$



The required volume is

$$\frac{2\pi}{3}\left(\frac{a}{2}\right)^3 - \frac{1}{8}\left(\frac{2}{3} - \frac{7\sqrt{6}}{27}\right)\pi a^3 \times 4$$

$$= \left(\frac{7\sqrt{6}}{54} - \frac{1}{4}\right)\pi a^3. \qquad \text{answer}$$

SOLUTIONS TO HOKKAIDO UNIVERSITY EXAMS

Examination A Science I, Pre-medical and Pre-dental Applicants

1. From the relationship between the roots and the coefficients, we have

$$\alpha + \beta = 2p$$

$$\alpha\beta = p^2 - 2p - 1$$

$$\therefore (\alpha - \beta)^2 - 2 = (\alpha + \beta)^2 - 4\alpha\beta - 2 = 8p + 2$$

$$(\alpha + \beta)^2 + 2 = 4p^2 + 2$$

$$\therefore \frac{1}{2}\frac{(\alpha - \beta)^2 - 2}{(\alpha + \beta)^2 + 2} = \frac{4p + 1}{4p^2 + 2} = n \quad \text{(an integer)}$$

$$4np^2 - 4p + 2n - 1 = 0.$$

Since p is a real number, either $n = 0$,
or $n \neq 0$ and the discriminant $= 4 - 4n(2n - 1) \geq 0$.

$$\therefore 2n^2 - n - 1 \leq 0$$

$$(2n + 1)(n - 1) \leq 0$$

$$-\frac{1}{2} \leq n \leq 1$$

$$\therefore n = 1$$

when $n = 0$, $p = -\frac{1}{4}$. answer

When $n = 1$,

$$4p^2 - 4p + 1 = 0$$
$$(2p-1)^2 = 0$$
$$p = \frac{1}{2}. \qquad \text{answer}$$

2. Let $G\ (X, Y)$ be the center of gravity.

$$\begin{aligned} X &= \frac{1}{3}\{x(t) + x(t+1) + x(t+2)\} \\ &= \frac{1}{6}(2^t + 2^{t+1} + 2^{t+2} + 2^{-t} + 2^{-(t+1)} + 2^{-(t+2)}) \\ &= \frac{1}{6}\left[2^{t+1}\left(\frac{1}{2} + 1 + 2\right) + 2^{-t-1}\left(2 + 1 + \frac{1}{2}\right)\right] \\ &= \frac{7}{12}\{2^{t+1} + 2^{-t-1}\} \geq \frac{7}{6} \end{aligned}$$

since $y + y^{-1} \geq 2$ when $y > 0$.

$$\begin{aligned} Y &= \frac{1}{3}\{y(t) + y(t+1) + y(t+2)\} \\ &= \frac{7}{6}\left(2^t - \frac{1}{4}2^{-t}\right) \\ &= \frac{7}{12}\left(2^{t+1} - 2^{-t-1}\right). \end{aligned}$$

(Since $2^t > 0$, Y assumes all real values.)

$$X + Y = \frac{7}{6} \cdot 2^{t+1}$$
$$X - Y = \frac{7}{6} \cdot 2^{-t-1}$$
$$\therefore X^2 - Y^2 = \frac{49}{36}.$$

The locus is the portion of

$$x^2 - y^2 = \frac{49}{36} \quad \text{where } x \geq \frac{7}{6}. \qquad \text{answer}$$

3. (1) The slope of PQ is $y/(x-1)$. The slope of the tangent of C at P is dy/dx. The line PQ is perpendicular to the tangent, so

$$\frac{dy}{dx} \cdot \frac{y}{x-1} = -1, \quad y\,dy = -(x-1)\,dx \qquad \text{answer}$$

(2) $\int y\,dy = \int -(x-1)\,dx$ $\therefore (x-1)^2 + y^2 = a\ (> 0)$. Hence the curve C is a circle with center at $(1, 0)$ and the radius $\sqrt{a}$, and

$$y = f(x) = \pm\sqrt{a - (x-1)^2}.$$

The condition that the curve C is tangent to the line

$$y = -\frac{2}{3}x + 5 \qquad \text{(i.e., } 2x + 3y - 15 = 0) \qquad (1)$$

is that the distance from the point $(1, 0)$ to line (1) is $\sqrt{a}$. Therefore,

$$\frac{13}{\sqrt{4+9}} = \sqrt{a} \quad \text{and} \quad \therefore a = 13$$

The fact that the y-intercept of (1) is positive implies that

$$y = \sqrt{13 - (x-1)^2}. \qquad \text{answer}$$

4. (1) Let

$$I = \lim_{n\to\infty} \frac{1}{n}\left\{\sum_{k=n+1}^{2n} \log k - n \log n\right\},$$

then

$$\begin{aligned} I &= \lim_{n\to\infty} \frac{1}{n} \sum_{k=n+1}^{2n} (\log k - \log n) \\ &= \lim_{n\to\infty} \frac{1}{n} \sum_{k=n+1}^{2n} \log \frac{k}{n}. \end{aligned}$$

This is the definite integral of $\log x$ over $[1, 2]$ obtained by dividing the interval into n equal portions.

$$\therefore I = \int_1^2 \log x\,dx.$$

(2) Let

$$P_n = \left(\frac{(2n)!}{n!n^n}\right)^{1/n}$$

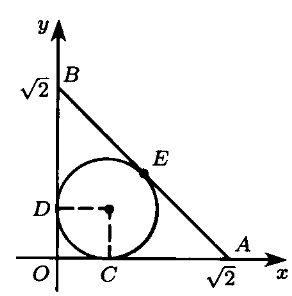
Then

$$\begin{aligned} \log P_n &= \frac{1}{n} \log \frac{(n+1)(n+2)\cdots(2n)}{n^n} \\ &= \frac{1}{2} \sum_{k=n+1}^{2n} \log \frac{k}{n}. \end{aligned}$$

$$\begin{aligned} \therefore \lim_{n\to\infty} \log P_n = I &= \int_1^2 \log x\,dx = (x \log x - x)_1^2 \\ &= 2\log 2 - 1 = \log \frac{4}{e}. \end{aligned}$$

$$\therefore \lim_{n\to\infty} P_n = \frac{4}{e}.$$

5. (1) $\triangle OAB$ is on the xy-plane.



The cross section of the sphere tangent to three sides is the inscribed circle of $\triangle OAB$. Let C, D, and E be points of tangency on OA, OB, and OC, respectively. Let r be the radius of the inscribed circle. Then

$$OA = OB = \sqrt{2}, \quad AB = 2$$

together with

$$OC = OD = r, \quad CA = CE, \quad BD = BE$$

imply

$$r = OC = OD = \frac{1}{2}(OA + OB - AB) = \sqrt{2} - 1.$$

The distance between the center of the sphere (r, r, z), $(z > 0)$, and C $(r, 0, 0)$ is the radius of the sphere, so

$$r^2 + z^2 = 6.$$

$$\therefore z^2 = 3 + 2\sqrt{2} = (\sqrt{2}+1)^2.$$

$$\therefore z = \sqrt{2} + 1.$$

The center of the sphere is

$$(\sqrt{2}-1, \sqrt{2}-1, \sqrt{2}+1). \qquad \text{answer}$$

(2) The portion of the sphere above the xy-plane is that portion of $x^2 + y^2 + z^2 = 6$ and $x \le \sqrt{2} + 1$. The volume of this portion is

$$\int_{-\sqrt{6}}^{\sqrt{2}+1} \pi(6 - x^2)\,dx = \pi\left[6x - \frac{1}{3}x^3\right]_{-\sqrt{6}}^{\sqrt{2}+1}$$

$$= \pi\left\{6\left(\sqrt{2}+1\right) - \frac{2\sqrt{2}+6+3\sqrt{2}+1}{3} + 6\sqrt{6} - 2\sqrt{6}\right\}$$

$$= \frac{\pi}{3}\left(11 + 13\sqrt{2} + 12\sqrt{6}\right). \qquad \text{answer}$$

Examination B Science II, Science III, and Fishery Applicants

1. See Exam A, #1.

2. (1) Let $P = (x, y)$. Then $\overrightarrow{PA} = (1 - x, -y)$, $\overrightarrow{PB} = (-1 - x, -y)$, therefore, the inner products are

$$(\overrightarrow{PA}, \overrightarrow{PB}) = (x^2 - 1) + y^2 = x^2 + y^2 - 1$$

$$(\overrightarrow{OA}, \overrightarrow{OB}) = -1.$$

So

$$(\overrightarrow{PA}, \overrightarrow{PB}) + 3(\overrightarrow{OA}, \overrightarrow{OB}) = 0$$

gives

$$x^2 + y^2 = 4.$$

Answer. The required locus is the circle with center at $(0, 0)$ and radius 2.

(2) $$|\overrightarrow{PA}|^2 \cdot |\overrightarrow{PB}|^2 = \{(1-x)^2 + y^2\}\{(1+x)^2 + y^2\}$$

$$= \{1 + x^2 + y^2 - 2x\}\{1 + x^2 + y^2 + 2x\}$$

$$= \{5 - 2x\}\{5 + 2x\}$$

$$= 25 - 4x^2.$$

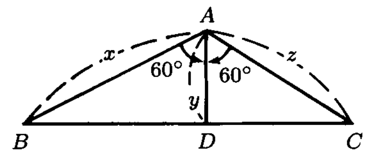
Since $0 \le x^2 \le 4$, $9 \le 25 - 4x^2 \le 25$.

$$\therefore 3 \le |\overrightarrow{PA}| \cdot |\overrightarrow{PB}| \le 5.$$

Answer. The maximum value is 5, and the minimum value is 3.

3. (1) Let $AD = y$, and $AC = z$, then

$$AB \cdot AC = xz = 1. \qquad (1)$$



$$\angle BAD = \angle CAD = 60^\circ$$

$$\triangle ABD + \triangle CAD = \triangle ABC$$

$$\frac{1}{2}xy\sin 60^\circ + \frac{1}{2}yz\sin 60^\circ = \frac{1}{2}xz\sin 120^\circ$$

$$\therefore y(x + z) = xz$$

Using (1)

$$AD = y = \frac{xz}{x+z}$$

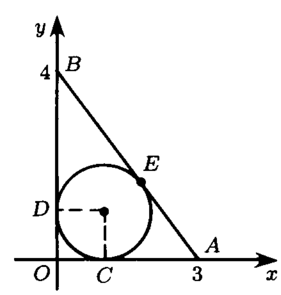
$$= \frac{1}{x+z} = \frac{x}{x^2 + xz} = \frac{x}{x^2+1} \qquad \text{answer}$$

(2) $$y = \frac{1}{x + \frac{1}{x}} \le \frac{1}{2\sqrt{x \cdot \frac{1}{x}}} = \frac{1}{2}.$$

The equality holds when $x = 1/x$, i.e., $x = 1$. Therefore, the maximum value is $1/2$ when $x = 1$.

4. See Exam A, #4.

5. $\triangle OAB$ is on the xy-plane. The cross section of the sphere tangent to the three sides is the inscribed circle of $\triangle OAB$. Let C, D, and E be points of tangency on OA, OB, and OC, respectively. Let r be the radius of the inscribed circle.



Then $OA = 3$, $OB = 4$, and $AB = 5$, which, together with $OC = OD = r$, $CA = CE$, and $BD = BE$, imply

$$r = OC = OD = \frac{1}{2}(OA + OB - AB) = 1.$$

The distance between the center of the sphere $(1, 1, z)$ $(z > 0)$ and C $(1, 0, 0)$ is the radius of the sphere

$$1^2 + z^2 = 2^2 \qquad \therefore z = \sqrt{3}.$$

Answer. Therefore, the center of the sphere is $(1, 1, \sqrt{3})$.

Examination C
Humanities Applicants

1. See Exam A, #1.

2. See Exam B, #2.

3. To prove

$$\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{3}}+\cdots+\frac{1}{\sqrt{n}}<2\sqrt{n}-2, \quad n\geq 2 \qquad (1)$$

by mathematical induction:

(i) For $n=2$, inequality (1) is $1/\sqrt{2}<2\sqrt{2}-2$.

$$(2\sqrt{2}-2)-\frac{1}{\sqrt{2}}=\frac{4-2\sqrt{2}}{\sqrt{2}}>0$$

establishes (1) for $n=2$.

(ii) Suppose (1) holds for $n=k$. That is,

$$\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{3}}+\cdots+\frac{1}{\sqrt{k}}<2\sqrt{k}-2.$$

Then

$$\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{3}}+\cdots+\frac{1}{\sqrt{k}}+\frac{1}{\sqrt{k+1}}$$
$$<2\sqrt{k}-2+\frac{1}{\sqrt{k+1}}.$$

Now

$$(2\sqrt{k+1}-2)-\left(2\sqrt{k}-2+\frac{1}{\sqrt{k+1}}\right)$$
$$=2(\sqrt{k+1}-\sqrt{k})-\frac{1}{\sqrt{k+1}}$$
$$=\frac{2}{\sqrt{k+1}+\sqrt{k}}-\frac{1}{\sqrt{k+1}}$$
$$=\frac{2\sqrt{k+1}-(\sqrt{k+1}+\sqrt{k})}{\sqrt{k+1}(\sqrt{k+1}+\sqrt{k})}$$
$$=\frac{\sqrt{k+1}-\sqrt{k}}{\sqrt{k+1}(\sqrt{k+1}+\sqrt{k})}>0.$$

This establishes (1) for $n=k+1$. By the principle of mathematical induction, (1) is established for all natural numbers $n\geq 2$.

4. Let

$$f(x)=ax+b.$$

Then

$$F(x)=x\int_1^{2x+3}(at+b)\,dt=x\int_1^{2x+3}f(t)\,dt$$

and

$$F'(x)=x\cdot 2f(2x+3)+\int_1^{2x+3}f(t)\,dt.$$

$$F(1)=\int_1^5(at+b)\,dt=\left(\frac{at^2}{2}+bt\right)_1^5=12a+4b.$$

$$F'(0)=\int_1^3 f(t)\,dt=4a+2b.$$

$$\left.\begin{aligned}F(1)=2=12a+4b\\ F'(0)=-10=4a+2b\end{aligned}\right\}\Longrightarrow a=\frac{11}{2},\ b=-16$$

$$\therefore f(x)=\frac{11}{2}x-16. \qquad \text{answer}$$

SOLUTIONS TO SHIGA UNIVERSITY EXAMS

Examination A
Education Division: Elementary, Secondary, Information Sciences

1. Since α' and β' are the roots of $x^2-x+q=0$,

$$x^2-x+q=(x-\alpha')(x-\beta').$$

When we substitute $x=\alpha,\beta$,

$$\alpha^2-\alpha+q=(\alpha-\alpha')(\alpha-\beta')=(\alpha'-\alpha)(\beta'-\alpha)$$
$$\beta^2-\beta+q=(\beta-\alpha')(\beta-\beta')=(\alpha'-\beta)(\beta'-\beta).$$

Multiplying the two equations above, we have

$$(\alpha'-\alpha)(\beta'-\alpha)(\alpha'-\beta)(\beta'-\beta)$$
$$=(\alpha^2-\alpha+q)(\beta^2-\beta+q)$$
$$=q^2+\left[(\alpha+\beta)^2-2\alpha\beta-(\alpha+\beta)\right]q$$
$$+\alpha\beta\left[\alpha\beta-(\alpha+\beta)+1\right]$$
$$=q^2+(p^2-2-p)q+1(1-p+1)$$
$$=q^2+p^2q-2q-pq-p+2 \qquad \text{answer}$$

since $\alpha+\beta=p$, $\alpha\beta=1$.

2. The condition $(A+B)^2=A^2+2AB+B^2$ is equivalent to

$$AB=BA$$

$$\therefore\begin{pmatrix}1&-1\\2&3\end{pmatrix}\begin{pmatrix}a&b\\1&-2\end{pmatrix}=\begin{pmatrix}a&b\\1&-2\end{pmatrix}\begin{pmatrix}1&-1\\2&3\end{pmatrix},$$

i.e.,

$$a-1=a+2b \qquad (1)$$
$$b+2=-a+3b \qquad (2)$$
$$2a+3=-3 \qquad (3)$$
$$2b-6=-7 \qquad (4)$$
$$(1)\Rightarrow b=-\frac{1}{2} \qquad (5)$$
$$(3)\Rightarrow a=-3 \qquad (6)$$

(5) and (6) satisfy (2) and (4).

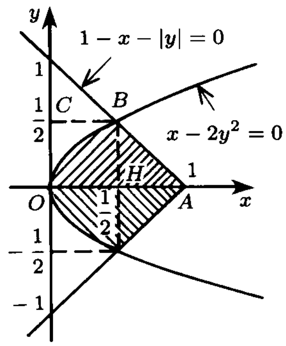
3. The intersecting points of the boundary curves

$$x-2y^2=0$$
$$1-x-|y|=0$$

are

$$\left(\frac{1}{2}, \frac{1}{2}\right), \left(\frac{1}{2}, -\frac{1}{2}\right).$$

Since the graph is symmetric with respect to the x-axis,



$$S = 2\left[\frac{(\frac{1}{2}+1)\cdot\frac{1}{2}}{2} - \int_0^{1/2} x\,dy\right]$$

$$= \frac{3}{4} - 2\int_0^{1/2} 2y^2\,dy = \frac{7}{12}. \qquad \text{answer}$$

4. First note that $a_n = S_n - S_{n-1}$ for $n \geq 2$.

For $n \geq 1$, $\quad a_1 + 2a_2 + \cdots + na_n = \dfrac{n+1}{n+2} \qquad (1)$

For $n \geq 2$, $\quad a_1 + 2a_2 + \cdots + (n-1)a_{n-1} = \dfrac{n}{n+1} \qquad (2)$

Subtracting (2) from (1) we have

$$na_n = \frac{n+1}{n+2} - \frac{n}{n+1} = \frac{1}{(n+2)(n+1)}$$

$$a_n = \frac{1}{n(n+1)(n+2)}$$

$$= \frac{1}{2}\left[\frac{1}{n(n+1)} - \frac{1}{(n+1)(n+2)}\right], \qquad n \geq 2.$$

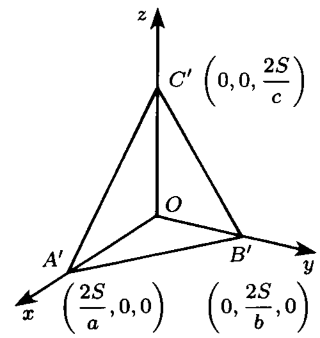
However, $a_1 = \frac{2}{3}$ from (1),

$$\therefore S_n = \frac{2}{3} + \frac{1}{2}\left[\left(\frac{1}{2\cdot 3} - \frac{1}{3\cdot 4}\right) + \left(\frac{1}{3\cdot 4} - \frac{1}{4\cdot 5}\right) + \cdots + \left(\frac{1}{n(n+1)} - \frac{1}{(n+1)(n+2)}\right)\right]$$

$$= \frac{2}{3} + \frac{1}{2}\left[\frac{1}{2\cdot 3} - \frac{1}{(n+1)(n+2)}\right]$$

$$= \frac{3n^2+9n+4}{4(n+1)(n+2)}. \qquad \text{answer}$$

5. (1)



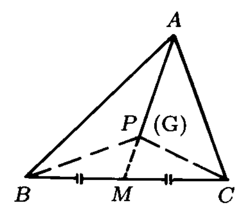
$$\triangle ABC = \triangle PBC + \triangle PCA + \triangle PAB$$

$$= \frac{1}{2}(ax + by + cz). \qquad \text{answer}$$

(2) From (1), point $P'(x, y, z)$ is on the plane

$$ax + by + cz = 2S.$$

Here $x > 0$, $y > 0$, $z > 0$, and P' moves inside of the $\triangle A'B'C'$.



(3) If P is the center of gravity of $\triangle ABC$, the extension of AP meets the midpoint, M, of BC.

$$\triangle ABP = \triangle ACP$$

$$\triangle ABP = \triangle BCP$$

$$\therefore ax = by = cz.$$

By taking this, together with (1), we have

$$x = \frac{2S}{3a}, \qquad y = \frac{2S}{3b}, \qquad z = \frac{2Ss}{3c},$$

which are the coordinates of the center of gravity of $\triangle A'B'C'$.

Examination B
Economics Division

1. When $y = x + k$ is tangent to $y = \sqrt{2x-1}$, there is exactly one point of intersection between them and also exactly one intersecting point between $y = x + k$ and the parabola $y^2 = 2x - 1$. Therefore, $2x - 1 = (x+k)^2$ has one solution and the discriminant D of $x^2 + 2(k-1)x + k^2 + 1 = 0$ is zero.

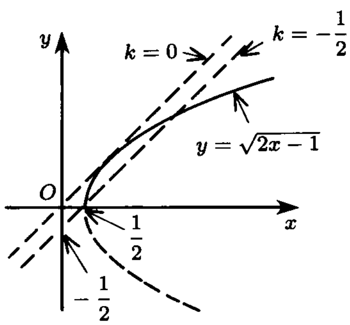
$$(k-1)^2 - (k^2+1) = 0$$

$$\therefore k = 0.$$

If $y = x + k$ passes through the vertex $(\frac{1}{2}, 0)$ of $y = \sqrt{2x-1}$, then

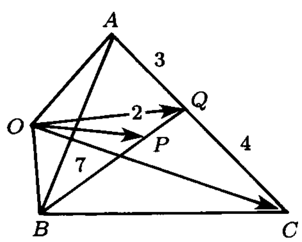
$$k = -\frac{1}{2}.$$

If $k > 0$, there is no point of intersection. If $k = 0$ or $k < -\frac{1}{2}$, there is one point of intersection. If $-\frac{1}{2} \le k < 0$, there are two points of intersection.



2. (1) $AQ : QC = 3 : 4$ implies that

$$\overrightarrow{OQ} = \frac{4\overrightarrow{OA} + 3\overrightarrow{OC}}{3+4} = \frac{4}{7}\overrightarrow{OA} + \frac{3}{7}\overrightarrow{OC}. \qquad \text{answer}$$



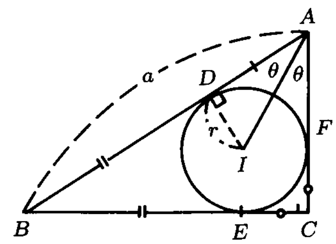
(2)
$$\overrightarrow{OP} = \frac{7\overrightarrow{OQ} + 2\overrightarrow{OB}}{2+7} = \frac{7(\frac{4}{7}\overrightarrow{OA} + \frac{3}{7}\overrightarrow{OC}) + 2\overrightarrow{OB}}{9} = \frac{4}{9}\overrightarrow{OA} + \frac{2}{9}\overrightarrow{OB} + \frac{1}{3}\overrightarrow{OC}. \qquad \text{answer}$$

3. (1) Let E, F be points of tangency of the inscribed circle I on side BC, CA, respectively. Then

$$\begin{cases} AD = AF \\ BD = BE \\ CE = CF. \end{cases}$$

Using the above relations

$$\frac{1}{2}(AB + AC - BC) = \frac{1}{2}[(AD + BD) + (AF + CF) - (BE + CE)] = AD.$$



(2) Since $ID \perp AD$, $ID = AD \tan\theta$. Also $AC = AB\cos 2\theta$, $BC = AB \sin 2\theta$.

$$\frac{r}{\tan\theta} = AD = \frac{1}{2}(a + a\cos 2\theta - a\sin 2\theta)$$

$$r = \frac{a}{2}(1 + \cos 2\theta - \sin 2\theta)\tan\theta. \qquad \text{answer}$$

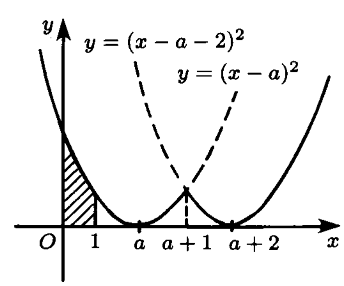
(3) Using the double angle formula for the result of (2), we have

$$r = \frac{a}{2}(2\cos^2\theta - 2\sin\theta\cos\theta)\cdot\frac{\sin\theta}{\cos\theta} = a(\sin\theta\cos\theta - \sin^2\theta) = \frac{a}{2}[\sin 2\theta - (1 - \cos 2\theta)] = \frac{a}{2}\left[\sqrt{2}\sin\left(2\theta + \frac{\pi}{4}\right) - 1\right].$$

$2\theta = \angle A$ is an interior angle of right triangle ABC, so $0 < 2\theta < \pi/2$ and hence $\pi/4 < 2\theta + \pi/4 < \frac{3}{4}\pi$. It follows that the maximum value of r is

$$\frac{a}{2}(\sqrt{2} - 1). \qquad \text{answer}$$

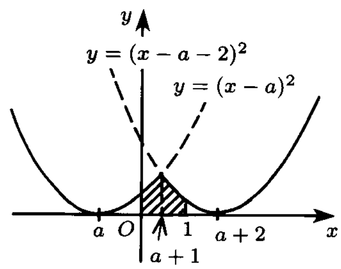
4. The graph of $f(x)$ is shown below with the solid line. At $x = a + 1$, f has a relative maximum.



(i) When $0 \le a \le 2$,

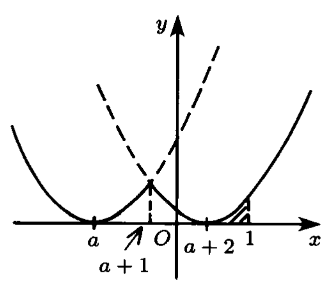
$$F(a) = \int_0^1 (x-a)^2\,dx = \frac{(x-a)^3}{3}\Big|_0^1 = a^2 - a + \frac{1}{3} = \left(a - \frac{1}{2}\right)^2 + \frac{1}{12}.$$

(ii) When $-1 \le a < 0$,



$$F(a) = \int_0^{a+1} (x-a)^2 dx + \int_{a+1}^{1} (x-a-2)^2 dx$$
$$= \left[\frac{(x-a)^3}{3}\right]_0^{a+1} + \left[\frac{(x-a-2)^3}{3}\right]_{a+1}^{1}$$
$$= -a^2 - a + \frac{1}{3}$$
$$= -\left(a + \frac{1}{2}\right)^2 + \frac{7}{12}.$$

(iii) When $-2 \le a < -1$,



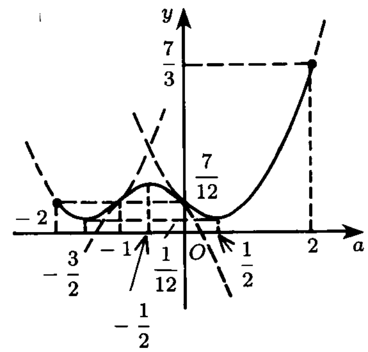
$$F(a) = \int_0^1 (x-a-2)^2 dx$$
$$= \frac{(x-a-2)^3}{3}\Big|_0^1$$
$$= a^2 + 3a + \frac{7}{3}$$
$$= \left(a + \frac{3}{2}\right)^2 + \frac{1}{12}.$$

From (i), (ii), (iii) we have the graph of $y = F(a)$ as shown below. It follows that the maximum value is

$$F(2) = \frac{7}{3}$$

and the minimum value is

$$F\left(\frac{1}{2}\right) = F\left(-\frac{3}{2}\right) = \frac{1}{12}.$$



SOLUTIONS TO SHIGA MEDICAL UNIVERSITY EXAM

Medical School Examination

1. (1) Suppose $m = \sqrt{a + \sqrt{b}} + \sqrt{a - \sqrt{b}}$ is a natural number where $a^2 \ge b$ and a, b are natural numbers. Squaring both sides, we have

$$m^2 = 2a + 2\sqrt{a^2 - b} \quad (1)$$
$$\therefore m^2 - 2a = 2\sqrt{a^2 - b}. \quad (2)$$

Squaring both sides, we have

$$(m^2 - 2a)^2 = 4(a^2 - b) \quad (3)$$
$$\therefore m^4 = 4(am^2 - b). \quad (4)$$

Since the right side is an even number, $m = 2n$ for some natural number n. Then (4) becomes $4n^4 = 4an^2 - b$,

$$\therefore b = 4n^2(a - n^2). \quad (5)$$

(5) and $b \ge 1$ imply $a - n^2 > 0$, therefore $n^2 < a$. From (3) $(2n)^2 - 2a \ge 0$, therefore $a \le 2n^2$. Together we have

$$n^2 < a \le 2n^2 \quad \text{and} \quad b = 4n^2(a - n^2). \quad (6)$$

Conversely, if a, b, n satisfy (6), set $m = 2n$ to establish (4) and hence (3). Since $m^2 - 2a \ge 0$, we have (2) and, therefore,

$$m = \sqrt{a + \sqrt{b}} + \sqrt{a - \sqrt{b}}.$$

(2) From the conditions in (1)

$$a^2 = 900 \ge b,$$
$$n^2 < 30 \le 2n^2, \quad (7)$$
$$b = 4n^2(30 - n^2).$$

From (7) $n = 4$ or $n = 5$. When $n = 4$, $b = 896 < 900$ and when $n = 5$, $b = 500 < 900$,

$$\therefore b = 500{,}896. \quad \text{answer}$$

2. (1) From the hypothesis, $bc\sin\theta = 2k$ where k is a constant. Differentiate both sides with respect to t:

$$(c\sin\theta)\frac{db}{dt} + (b\sin\theta)\frac{dc}{dt} + bc\cos\theta\frac{d\theta}{dt} = 0. \qquad (1)$$

θ is an acute angle, so $\cos\theta \neq 0$ and it follows that

$$\frac{d\theta}{dt} = -\frac{\sin\theta}{bc\cos\theta}\left(c\frac{db}{dt} + b\frac{dc}{dt}\right). \qquad (2)\ \textit{answer}$$

(2) From the law of cosines, $a^2 = b^2 + c^2 - 2bc\cos\theta$. Differentiate both sides with respect to t:

$$2a\frac{da}{dt} = 2b\frac{db}{dt} + 2c\frac{dc}{dt} - 2\left\{(c\cos\theta)\frac{db}{dt} + (b\cos\theta)\frac{dc}{dt} - (bc\sin\theta)\frac{d\theta}{dt}\right\}.$$

Divide both sides by 2 and substitute (2) in the expression:

$$a\frac{da}{dt} = \left(b - \frac{c}{\cos\theta}\right)\frac{db}{dt} + \left(c - \frac{b}{\cos\theta}\right)\frac{dc}{dt}$$

$$\frac{da}{dt} = \frac{1}{\sqrt{b^2 + c^2 - 2bc\cos\theta}} \times \left\{\left(b - \frac{c}{\cos\theta}\right)\frac{db}{dt} + \left(c - \frac{b}{\cos\theta}\right)\frac{dc}{dt}\right\} \text{(3) answer}$$

(3) $\dfrac{da}{dt} = \dfrac{1}{10}\{(10 - 10 \times 2) \times 2 + (10 - 10 \times 2) \times (-1)\} = -1$ answer

3. (1) An equation for the line AB is

$$\frac{x}{s} + \frac{y}{t} = 1.$$

$$\therefore y = t\left(1 - \frac{x}{s}\right). \qquad \text{(1) answer}$$

Here $\overrightarrow{AB}^2 = s^2 + t^2 = 1$, so $t = \sqrt{1 - s^2}$; and the y-coordinate of the point of the intersection of (1) and the line $x = x_0$ is

$$y_0 = \sqrt{1 - s^2}\left(1 - \frac{x_0}{s}\right). \qquad \text{(2) answer}$$

(2) Fix x_0 and vary s between x_0 and 1. We shall investigate the range of y in (1). Let $y = f(s)$ in (2). Then

$$f'(s) = \frac{-s}{\sqrt{1 - s^2}}\left(1 - \frac{x_0}{s}\right) + \sqrt{1 - s^2} \cdot \frac{x_0}{s^2} = -\frac{s^3 - x_0}{s^2\sqrt{1 - s^2}}$$

$$= \frac{(s - \sqrt[3]{x_0})(s^2 + s\sqrt[3]{x_0} + \sqrt[3]{x_0^2})}{s^2\sqrt{1 - s^2}}.$$

Let $\alpha = \sqrt[3]{x_0}$. Since $s^2 + s\alpha + \alpha^2 > 0$, $f'(s) \geq 0 \Leftrightarrow (s - \alpha) \leq 0$.

s	x_0		α		1
$f'(s)$		+	0	−	
$f(s)$	0	↗	rel. max	↘	0

$$f(\alpha) = \sqrt{1 - \alpha^2}(1 - \alpha^2) = (\sqrt{1 - \alpha^2})^3.$$

That is, $0 \leq y \leq (\sqrt{1 - \alpha^2})^3$. Since $0 \leq x_0 \leq 1$, the range of the region covered by the line AB is

$$0 \leq x \leq 1 \quad \text{and} \quad 0 \leq y \leq \left(\sqrt{1 - \sqrt[3]{x^2}}\right)^3. \qquad \text{answer}$$

4. (1) Let $\vec{l} = (p, q, r)$.

The normals to Π_1, Π_2 are $\vec{n_1} = (a, 1, 1)$, $\vec{n_2} = (1, -a, a)$, respectively. Both are perpendicular to $\vec{l}$:

$$\begin{cases} \vec{n_1} \cdot \vec{l} = ap + q + r = 0 \\ \vec{n_2} \cdot \vec{l} = p - aq + ar = 0. \end{cases}$$

$$\therefore p = \frac{-2ar}{a^2 + 1}, \qquad q = \frac{(a^2 - 1)r}{a^2 + 1}.$$

Choose $r = a^2 + 1$. Then

$$\vec{l} = (-2a, a^2 - 1, a^2 + 1). \qquad \text{answer}$$

(2) Observe that $(-1, a, a)$ is on π_1 and π_2, therefore it is on the line l. An equation of l is

$$\frac{x + 1}{-2a} = \frac{y - a}{a^2 - 1} = \frac{z - a}{a^2 + 1} \qquad (1)$$

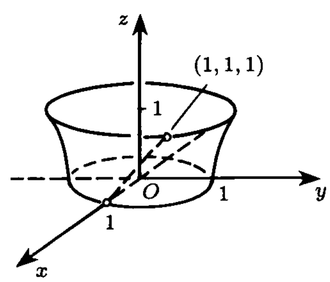
(however, when the denominator is zero, we will set the numerator equals to zero). The x-, y-coordinates of points of intersection of the plane $z = t$ and (1) are obtained by setting $z = t$ in (1):

$$\begin{cases} x + 1 = \dfrac{(t - a)(-2a)}{a^2 + 1} \\ y - a = \dfrac{(t - a)(a^2 - 1)}{a^2 + 1} \end{cases} \quad \therefore \begin{cases} x = \dfrac{-2at + (a^2 - 1)}{a^2 + 1} \\ y = \dfrac{(a^2 - 1)t + 2a}{a^2 + 1} \end{cases} (2)$$

Eliminating a in (2), we have $x^2 + y^2 = t^2 + 1$, i.e., the curve that results from cutting the locus of l by the plane $z = t$ is a circle with center at $(0, 0, t)$ and radius $\sqrt{t^2 + 1}$.

(3) The area of the cross section of this graph cut by $z = t$ is

$$\pi(t^2 + 1).$$



The required volume is

$$\pi\int_0^1 (t^2 + 1)\,dt = \pi\left(\frac{t^3}{3} + t\right)_0^1 = \frac{4\pi}{3}. \qquad \text{answer}$$

大学入試

THE MAA
culus Collection

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The value of our contributions will now be judged by the larger mathematical community, but I was right in thinking that I could find in our consortia the great abundance of talent necessary for an undertaking of this magnitude. Anita Solow brought to the project a background of editorial work and quickly became not only the editor of one our publications, but also a person to whom I turned for advice regarding the project as a whole. Phil Straffin, drawing on his association with UMAP, was an ideal person to edit a collection of applications and was another person who brought editorial experience to our project. Woody Dudley came to the project as a writer well known for his witty and incisive commentary on mathematical literature and was an ideal choice to assemble a collection of readings.

Bob Fraga and Mic Jackson, the junior editors in our group, justified the confidence we placed in them and brought to the project an enthusiasm and freshness from which we all benefited. They were able at all points in the project to draw upon an excellent corps of gifted and experienced writers. When, in the last months of the project, Mic Jackson took an overseas assignment on an Earlham program, it was possible to move John Ramsay into Mic's position precisely because of the excellent working relationship that existed on these writing teams.

The entire team of five editors, our project evaluator, George Andrews, and the syllabus coordinator, Andy Sterrett worked together as a harmonious team over the five-year duration of this project. Each member, in turn, developed a group of writers, readers, and classroom users as necessary to complete the task. I believe my chief contribution was to identify and bring these talented people together and see that they were supported both financially and by human resources available in the schools that make up two remarkable consortia.

enduring records of the reform movement."

We have now finished that record, a five volume collection, each volume guided by the needs as we listed them above:

1. *Learning by Discovery*, Anita Solow, editor
2. *Calculus Problems for a New Century*, Robert Fraga, editor
3. *Applications of Calculus*, Philip Straffin, editor
4. *Problems for Student Investigation*, Michael Jackson and John R. Ramsay, editors
5. *Readings for Calculus*, Underwood Dudley, editor

The entire collection will appear in the MAA Notes, and will be introduced at the San Antonio meetings.

Footnote

ACM Colleges: Beloit, Carleton, Coe, Colorado, Cornell, Grinnell, Knox, Lake Forest, Lawrence, Macalester, Monmouth, Ripon, St. Olaf, University of Chicago.

GLCA Colleges: Albion, Antioch, Denison, DePauw, Earlham, Hope, Kalamazoo, Kenyon, Oberlin, Ohio Wesleyan, Wabash, Wooster.

Job Search Diary

PART 2

Edward F. Aboufadel

In the October issue of FOCUS, Edward Aboufadel described the first stage of his search for an academic position in last year's hiring round. At the time, Ed was a graduate student completing his PhD in mathematics at Rutgers University. That first installment of his job search diary took us through the fall, up to the end of November. This month's episode describes the job search through to early February.

December 5: Here's the score at this point: I have 40 applications out. A Chinese student in our department has 60. Two Americans that I know are just starting to apply, and a third American has 4 applications out, since he wants to stay in New Jersey. I have more thoughts about better ways to word these job postings. Why can't departments be clearer about whom they want to apply for these positions? I appreciate the departments that say "please send a copy of your most recently published paper," since it says to me: "if you haven't had anything published, don't apply." I would like to see ads that say "this position is intended for new PhDs." I understand that departments like to be vague in their position announcements so as not to turn away someone who actually might be a good fit, but, on the other hand, if your search committee is tired of swimming through applications, maybe the announcements should be more direct so as to get fewer applicants. Some ideas: "only graduates of Princeton, Harvard, or Berkeley need apply"; "if you do not enjoy teaching, don't even think of applying here"; "this is a tenure-track position — we are NOT hiring new PhDs". OK, maybe I'm getting a bit silly here.

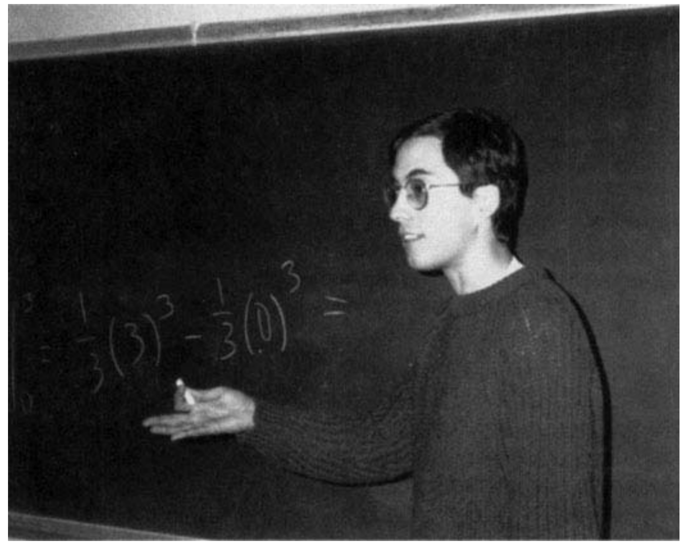
December 14: I have put together 17 more applications today to raise my total to 57. I have become much more aware of deadlines, and I have decided that I will wait until mid-January to apply for any position with a deadline of February 1. I wish every job announcement had a stated deadline, particularly those on the AMS e-MATH system. Last month at two job fairs on campus, I talked to recruiters from IBM and AT&T. These recruiters were primarily interested in hiring graduating undergraduates, but they took my resume anyway and said they would pass it on to the appropriate people. This has been the extent of my non-academic job search so far. I received letters this week from both corporations stating, in effect, that they are not hiring right now, but might be in six months or so. I don't find this very encouraging, but, on the other hand, I have been primarily focusing on the academic job market. In six months, if I don't have an academic position, I will have to go back to these and other companies to see if they are hiring.

I sent a letter two weeks ago to St. John's College in Maryland. They have an unusual program that they call the "Great Books" program. They also had an advertisement on e-MATH. I wrote to express my interest in getting acquainted, as, from what I read in their catalog, I am not sure if I want to apply for a job. I received a short postcard from them this week that said that they will not be hiring this year. This is the first place that I have heard say this.

Let's hope that only a few follow.

Many schools have sent letters of acknowledgement of my application. I have mixed feelings about this. On the one hand, it is a relief to know that my letter actually got there and to learn if my application is incomplete. On the other hand, I'm dying to know what kind of impact, if any, my application is making. Most likely, departments haven't made it past the "put it over there with the rest" stage, but I'm feeling impatient.

With the letter of acknowledgement, some schools send an affirmative action form. I am quickly tiring of filling these out. I also don't think it is very wise to ask an applicant to pay the postage to mail the form back.



Edward F. Aboufadel demystifies calculus for his class.

Practically all announcements of positions end with "women and minorities are particularly encouraged to apply." As a white male, I have to wonder if that sentence really means anything. Am I not encouraged to apply? The current national discussion about quotas applies here too, doesn't it? What does it mean when an announcement doesn't encourage women and minorities to apply?

Some schools also request transcripts. What does this mean? Must the transcripts be official, or can I copy the unofficial ones that I have? And why do these schools need my transcripts in order to decide if they want to interview me? At this point, I don't think they would worry about grade point average. Do they think that someone will lie about their credentials? Is this some way to lessen the number of applications they receive? Given the cost of official transcripts, this would be a clever, though perhaps not healthy, idea.

I figure that by the time I am done with this process, I will have applied to at least a half-dozen campuses which are part of the SUNY system. I wonder if there is some way that these campuses could work together to hire people. Following this idea to its logical conclusion, we would end up with the system used by medical schools and hospitals, as was explained in *Science* last year. If a system like that would save a lot of departments money, I'm sure they would consider it.

December 18: I received this today by email:

>From: for L R King <STDAVIS@apollo.davidson.edu>

>Subject: Application to Davidson College

>To: aboufade@math.rutgers.edu

>Mr. Aboufadel,

>The evaluation of applications for our position is well under
>way. We like what we have seen of your application, but it is still
>incomplete. The following need to arrive VERY SOON:

>
> * A copy of your undergraduate transcript.

> * A copy of your graduate transcript.

>
>Please let me know that you have received this message.

I think email is wonderful, and I am glad that they like what they have seen of my application.

January 3, 1992: I received my first rejection letter today. It was for the Pew Teacher-Scholar Fellowship. Actually, the letter announced that the Fellows for 1992-1993 have been chosen. I guess I was to use a little bit of logic to deduce that I was not one of those chosen.

I wish I had some feedback on this. The facts are that I was not chosen for this Fellowship and I was not even interviewed for it. I would like to know if (1) based on my credentials, I was too ambitious to think that I could be considered, or (2) my credentials are acceptable, but my application itself could have been improved. Could I be so bold as to write Dr. Hornbach and ask him? Perhaps I don't want to know the answer.

While I'm being depressed, today I took a close look at the December issue of *Employment Information in the Mathematical Sciences*. In this issue are the resumes of all those people who will be participating in the Employment Registry in Baltimore next week, plus a handful more who will not but who wish to have their resume published. There are 534 resumes in this book, including mine. We could take all these people and start an electoral college! (OK, bad multidisciplinary joke.) A glance at my registration information for the meeting indicates that the ratio of applicants to jobs this year at the Employment Registry is near 5:1, which is either a record or else close.

What was also troubling is that many, maybe even half, of the resumes are from people who have already graduated. I have to compete with these people! And, looking at my resume, I see that I could have filled it in a lot more completely than I did. It's funny—last month I was starting to feel confident about getting hired. Now I'm getting anxious again. Time to apply for some more positions.

January 6: Talked to a Chinese student today who is in my department and is also looking for a job. He told me that he has received a few rejection letters, one of which said that they were not looking for someone in his specialty. Another said that the position is no longer open because of financial constraints. I also called both Dartmouth College and Bloomsburg University today. For Dartmouth, I wasn't certain if they had a complete application packet from me. For Bloomsburg, I wanted to know if they could live with unofficial transcripts at this stage. (They could.) Tomorrow I am heading for Baltimore. I spent this afternoon trying to find out a few facts about the employers who will be interviewing in Baltimore. In particular, I tried to find out which schools have institutional memberships in the AMS and the MAA, which might be an indication of the level of professionalism of the program. I also went through the 1990 survey of salaries produced by the AAUP, which is the union which represents the faculty at Rutgers. Since I have some choice as to which schools to interview with, I might as well factor in potential salary as a consideration. What can I expect from these interviews? Only that if I leave a good impression, I might get a second, longer interview some time in the future. I certainly wouldn't hire anyone on the basis of a fifteen-minute interview.

One question I will need answered is whether or not I should sign up for interviews with schools that I have already applied to. I have told all of these schools that I would be in Baltimore, and there is an interview session on Friday afternoon where the schools indicate which candidates they would like to interview. Since these schools have my application materials, they should be able to decide if they want to interview me then.

I can tell that this is going to be a stressful week.

January 9: I arrived in Baltimore on the 7th for the Joint Meetings. The primary reason I am here is to participate in the Employment Registry (ER).

So far, the ER has struck me as a big cattle call. The whole set-up is in a huge hall known simply as Hall D. In one part of the hall, the resumes of all the participating applicants, including mine, are displayed, as are announcements of positions.

Yesterday, I submitted a request for interviews for today. I submitted the names of 12 schools. This morning I received a schedule for today. I have 5 interviews, 1.5 more than what could be expected according to the ER people.

People are anxious here. I've noticed that some people are using the message center to contact schools to arrange interviews outside of the ER process. Although the ER people recommend doing this for maybe one or two schools, it looks like a couple of people have sent messages to every school that is interviewing. I've also noticed that a few people are using the message center to pass along their resumes. I imagine that the U.S. mail would be safer and more reliable. On the other hand, this could get someone's attention.

As for myself, I have let Dartmouth College know that I am here and Bloomsburg University has invited me to their hotel room for an informal chat. I was told by a professor at Rutgers that people from Davidson College were talking about me, and yesterday I noticed that someone who was looking at the book of resumes had circled my name. I guess right now I'm latching onto whatever information I can.

January 13: I have returned from the Baltimore meeting, which I felt went pretty well. On the 9th and 10th, I had interviews with a number of schools.

All the schools that I interviewed with through the Employment Registry consider teaching as important or more important than research. Given my teaching experience as a graduate student (I have taught 6 courses at Rutgers University) and my feelings about teaching vs. research, I had a leg up on other candidates.

As for the interviews themselves, they were quite short (15 minutes), and, for the most part, it felt more like I was interviewing the schools rather than that they were interviewing me. Many of the interviewers spent most of the 15 minutes telling me about the department. All asked me if I had any questions about the department. Questions I asked of each school were: Is there any computer-aided instruction? What kind of computing facilities are available for faculty and students? How many math majors does the department have? Is the department satisfied with that number? What is the lowest level course taught in the department? Does the school have a research library, and if not, where do faculty go to read journals? Does the department field a Putnam team?

I wish I had asked the following question: What is the mission of your department?

Through these questions, I got a picture about each department and their attitudes about research and their students. There was some uniformity in the responses. For instance, nearly all the departments that I interviewed with had a program in place for computer-aided instruction. (Could I say the same about a random sample of research universities?) Nearly all places promised a brand-new desktop computer for each new faculty hired. Each could name a research university near enough that I could travel to if necessary.

Two of my interviews left me uninterested in working for those schools. I wish I could just cross these schools off of my list, but these are desperate times for new PhDs, and I may not be able to be choosy.

I was pleased to find that two schools requested a second interview with me through the Employment Registry: Davidson College and Ball State University. When I learned this news on Friday morning, For the first time I started thinking that this was no longer just an exercise in letter writing and being organized. Over the next two months, I will be making some serious decisions about my life.

*Please see **Job Search** on page 20*

Job Search *from page 19*

A good question to ask is why I haven't made these decisions sooner. For instance, do I want to work at a liberal arts college or a research university? After studying at Michigan State and at Rutgers, working for a liberal arts college feels like a demotion to me. Some of the speakers in Baltimore observed that I am not alone feeling this way. It is true that graduate study at a large research university is primarily training for a position at a large research university. (For example: my department underwrites my membership in the AMS, but I had to pay out of my own pocket to join the MAA.) To consider working for a liberal arts college seems like an act of rebellion.

While I was in Baltimore, I received a few letters indicating that certain schools will have decided by mid-February whom they want to invite to their campuses for a full-fledged interview. Also, today I will be putting together my final batch of applications (I hope), which should bring my total to approximately 70.

January 20: There is an idea about this process that I had that I am starting to question. I thought that the order in which offers of position would be made would be as follows: first the prestigious postdocs, followed by the well-paying instructorships at the big research universities, then the liberal arts colleges and smaller universities, and then the rest. So far I know of one prestigious postdoc that was awarded, the Pew Teacher-Scholar Fellowship. I suppose others have also been awarded or are about to be awarded. But what is going on at the research universities? Penn State had an application deadline of October 10, yet it wasn't until last week that I received a letter from them acknowledging receipt of my application. Meanwhile, a letter from the University of Toronto states that their search committee will meet in late February or early March to begin considering applications. A friend at Michigan State describes the situation there as "We've thrown all the applications in a room and will get to them later". Here at Rutgers, each applicant has a folder but now there is a serious question of whether or not the department will be able to hire anyone.

Meanwhile, in Baltimore, some of the liberal arts colleges and small universities that I talked to said that they would have their short lists ready by the end of January and would send out invitations for interviews in early February. A letter from Macalester College indicated the same.

I recognize that this information is anecdotal, but it makes me wonder.

I heard last week that the University of Wisconsin–Madison has received 900 applications for positions in the Mathematics Department. Unfortunately, there are no positions available at Wisconsin. If there was a position advertised, I would have applied, and I'm sure that I am not alone.

Received my second rejection letter over the weekend. Actually, it is not quite a rejection letter, since I am still being considered for the position. But how else am I to react to the following:

". . . we will be giving preference to those with backgrounds and interests in discrete or geometrical modeling or dynamical systems. We also consider a demonstrated commitment to the blending of pure and applied mathematics, statistics, and computer science essential. It doesn't look like your background and qualifications match our preferences. Of course, we may not be able to hire an individual who matches our preferences. So, if you still wish to be considered for our opening, you will need to complete our application packet. . . ."

Who would want to be in a position where you are cognizant that you are not what was wanted? Please don't tell me if I am your 20th or 80th or 200th choice.

On the other hand, sometime in the future, I may come to appreciate the honesty of this letter. After all, at least in this case I know why I am being rejected (or being put way down on their list).

January 25: I received two more rejection letters this week, from Vanderbilt and from Wright State. One I deserved, while the other I am confused about.

In both letters, the schools said that they were not looking to hire someone in my area of specialization. In the case of Wright State, they were absolutely right. I went back to the job announcement and discovered that they were looking for someone in operator theory. I don't understand how I ever decided to apply there. On the other hand, the job announcement for the Vanderbilt position said the following: "We are especially interested in someone who works in one of the areas of departmental strengths which include universal algebra, differential equations, approximation theory, operator theory, mathematical biology, applied mathematics, graph theory, and topology." The last I checked, my dissertation was in ordinary differential equations with some connections to mathematical biology. I am sending the chair at Vanderbilt a letter. The latest rumor is that what started as three open positions at the University of Illinois is now zero. I heard this from a mathematician visiting Rutgers this month with whom I've been acquainted for a number of years. When I told him that I applied to 67 different schools, he said that was not enough. Ten years ago, when he was looking for a position, he applied to 120 schools.

Some of my friends here at Rutgers tell me that they continue to get similar advice. For example, that it would be wise to apply to every college and university in New Jersey because you never know if a position is going to open up and there will not be time to advertise it.

I have two reactions to this sort of thing. First, does this really have to be so hard? Second, I am getting tired of hearing all these tenured (ie: employed) faculty members fret about this year's job market. People come up and start talking to me about the situation, and I'm the one who should be anxious. I'm not saying that I'm not anxious, but I wouldn't mind a little perspective from the people above me.

To be fair, some faculty members have provided just that, observing, for example, that it would not at all be unprecedented if I had to wait until May or June until I get a job offer. But it appears that many tenured faculty are finding this year's job situation a bit unnerving. It could lead to fewer graduate students in the future.

February 1: I had lunch today with Nigel, a fellow student who is also going through a job hunt this year. He has sent out 73 applications at this point and has received 5 rejections. He has heard that there is a hiring freeze in the California state system and that there has been one for six months, so any job announcements other than named instructorships (e.g., Hedrick) are for positions that most likely don't exist. He has also heard that positions at the University of Washington in Seattle have disappeared due to funding problems.

More so than I, Nigel has had to fill out a number of application forms sent by the departments he applied to. Apparently the announcement for positions at Princeton said that to apply, an application form needed to be completed, so send us email and we will send you the form. This seems a lot nicer than the process of sending a department an application packet and then having them send you application forms to fill out. In this way, the department gets the information they want in the form they want it in and the applicant saves 29 cents.

I have been trying to decide whether or not to apply for more positions. On the one hand, I feel that there must be a good number of departments that I have already applied to that would be a good match for me. On the other hand, if the number of good matches for me is 10, and if there are 12 other people out there who are also good matches for those ten schools, then someone is going to lose out.

The problem at this point is that hiring freezes and vanishing positions are all I've heard about in the last ten days or so. For example, the rumor about the University of Illinois was confirmed this week. I am trying to patiently await positive news, but it is difficult.

February 9: This past week has been just a cascade of bad news. I received rejection letters or email from Mary Washington College, SUNY-Brockport, Shepherd College, and the University of Richmond. Mary Washington College said that they had made offers to two people and that the offers were accepted. (At least someone is hiring.) SUNY-Brockport said that they had gone through the applications once and that I was not in the "FOR FURTHER CONSIDERATION" classification. Shepherd College said something similar, although they mentioned in the letter that they had decided to focus on candidates who also have a computer science background.

At least with these three places, I can console myself with the fact that I was not terribly interested in them, either. On the other hand, I had higher hopes for the University of Richmond. I had an interview with a member of that department in Baltimore, but the chair there said the following in the email message that he sent me: ". . . it is unlikely that you will be considered further. We have more than 300 completed applications and have had to make difficult choices with limited information."

This rejection led me to look over the letter that I sent the University of Richmond. I am extremely embarrassed. There is a typo in the first sentence. This question that I brought up with the Pew Fellowship arises again. Is it a question of inadequate credentials or am I saying the wrong things in my cover letter or have I just been unlucky?

This time I have actually sent a response to the chair at Richmond, asking for some information about their "difficult choices." I recognize that this might be unorthodox, but this is an unorthodox year.

On Wednesday, I talked to a relative of mine, Albert Fadell, at SUNY-Buffalo. Most of our conversation had to do with considering my interests in research versus my interests in teaching and whether or not I would be happy at a place like SUNY-Buffalo. The answer to that question is probably not, and also probably not at any other "cutthroat" (Dr. Fadell's word) big research university. I am beginning to wish that I could start this whole process over again. I probably would have applied to different places than I did and I probably would have said things differently in my application packet.

Well, with 9 rejection letters in hand, I am definitely going to send out one more wave of applications. The January Notices and my most recent look at the job listings on e-MATH have given me another dozen places to apply to, whose deadlines are February 15 or after.

I have just received a response from the University of Richmond. (Once again, isn't email great!) The chair, Joe Kent, writes the following:

>Let me say that you made a good impression in the interview
>with Dr. MacCluer in Baltimore and we had you near the top
>of our list. When the cut was made we had to eliminate some
>fine people. The ones that made the cut (10 total) were very
>outstanding. Fortunately, several seem to be interested in
>our position and would be able to work with current faculty.
>This is a difficult year and there will be many disappointed
>people. I only wish I had more positions to offer.
>I cannot pick out something that was "wrong" with your application
>or that should be changed. Good luck to you.

This makes me feel better.

To be continued . . .

Classification Society of North America

CALL FOR PAPERS

1993 ANNUAL MEETING

24–26 JUNE 1993, PITTSBURGH, PA

The 1993 annual meeting of the CSNA will be held on the campus of the University of Pittsburgh starting Thursday evening, 24 June and continuing until Saturday afternoon, 26 June. The purpose of the annual meeting is to provide a forum for presentation and cross-disciplinary discussion of data oriented approaches to classification and understanding of complex data structures.

This meeting marks the twenty-fifth anniversary of the CSNA. Invited sessions will feature the application areas of Numerical Taxonomy, Numerical Ecology, Molecular Biology, and Information Retrieval. The CSNA meeting will directly precede the annual meeting of the ACM Special Interest Group on Information Retrieval (ACM SIGIR) and the Numerical Taxonomy meeting, both being held in Pittsburgh.

The program will include plenary talks by invited speakers and symposia on Neutral Network, Genetic Algorithm, Multivariate Density Estimation, and Visual Clustering Approaches to Classification. As in the past, there will be invited and contributed papers by CSNA members, nonmembers, and students in the areas of cluster analysis, multidimensional scaling, and related methods of exploratory data analysis and their use in applications. The programs for previous meetings can be found in the *Journal of Classification*. Because of the informal nature of the meetings, speakers often present research that is currently in progress.

The meeting will be preceded by an optional short course on Classification and Clustering and Multivariate Density Estimation and Visual Clustering on Thursday, 24 June.

We are interested in soliciting presentations in all areas of the scientific study of classification and clustering. Persons wishing to present a talk, propose a symposium, or request information about local arrangements, should contact Stephen C. Hirtle, Department of Information Science, University of Pittsburgh, Pittsburgh, PA 15260 (412) 624-9434, FAX (412) 624-5231, email cnsa93@lis.pitt.edu.

***SUMMA** from page 14*

• **Evaluation:** How will you judge the success of the planning?

• **Budget:** How will your planning funds be spent — personnel, travel, materials, telephone, workshop attendance, release time, etc.?

• **Commitment:** What is the potential for long-term commitment of the host institution?

• **Future Funding:** What is the likelihood of institutionalization through local or state funding (perhaps after start-up federal funding from a variety of programs)?

• **Support:** To what extent have you demonstrated the ability to mobilize internal and community resources to sustain intervention projects?

• **Adaptation:** How might a successful existing project be adapted to your local conditions or what is the need for innovation?

SUBMISSION OF PROPOSALS

Proposals should be submitted as soon as possible, but no later than 1 February 1993. All proposers will be notified by 15 February 1993. The MAA/SUMMA intends to make 12-20 grants.

For further information contact: Dr. William Hawkins, Director of the SUMMA Program, Mathematical Association of America, 1529 Eighteenth St. NW, Washington, DC 20036 Telephone: (202) 387-5200, FAX: (202) 265-2384, email: summa@maa.org.

Crux Mathematicorum

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The Mathematical Association of America's more than 32,000 members all receive FOCUS and its Employment Advertisements as a standard membership benefit. FOCUS readers describe themselves as mathematicians teaching in secondary schools, colleges and universities, or working in business, industry, and government.

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COLBY COLLEGE
DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

Subject to final budgetary approval, we expect to have a tenure–track opening in pure mathematics at the assistant professor level, commencing 1 September 1993. PhD required. The salary is competitive and based on experience.
Colby is a small, private, highly selective liberal arts college located in central Maine. The student body numbers some 1700, the faculty 180. The Department of Mathematics and Computer Science currently numbers nine full–time and two part–time. All full–time faculty members have the PhD. We have major and minor programs in mathematics and computer science.
We are a young, active department, which places a high value on both teaching and research. The annual teaching load is 5 courses. The largest class size is 30.
We have no preferences regarding area of research specialization within pure mathematics. Candidates who are able to demonstrate excellence in teaching and are familiar with the use of computer algebra systems (in particular, Mathematica) in mathematics education are likely to be ranked higher in our selection process. An ability to teach some basic courses in computer science would also be desirable.
Colby is an AA/EO employer and actively encourages applications from women and minority candidates. Particularly well–qualified female candidates may be eligible for appointment to one of the College's Claire Booth Luce Assistant Professorships for Women Scientists.
Review of applicants will begin 20 January 1993, and continue until the position is filled.
Send a letter of application and a current curriculum vita to: Keith Devlin, Chair, Department of Mathematics and Computer Science, Colby College, Waterville, Maine 04901. Also, arrange for three letters of reference to be sent to the same address. These letters should deal with both your research and your teaching abilities.

UNIVERSITY OF REDLANDS
DEPARTMENT OF MATHEMATICS
P.O. BOX 3080, REDLANDS, CA 92363

The Department of Mathematics invites applications for one or two tenure–track positions at the assistant professor level beginning 1 September 1993. Responsibilities include teaching six undergraduate courses per year, including computer–based courses; directing student research projects; and engaging in scholarly activity. Requirements include the PhD in mathematics (any specialization) and evidence of excellence in and commitment to undergraduate teaching.
The University of Redlands, which enrolls 1500 undergraduates, is a selective, private, comprehensive university located in Southern California.
To apply, submit a letter of application, a resume, and three letters of reference, two of which must address teaching, to Dr. Allen Killpatrick, Chair. Application deadline is 5:00 p.m., 15 February 1993. Department representatives will attend the AMS–MAA Joint Meetings in San Antonio, Texas. The University of Redland in an EEO employer. We especially encourage women and members of minority groups to apply.

MATHEMATICS EDUCATION
CORNELL UNIVERSITY

Coordinator of Cornell/Schools Mathematics Resource Program (CSMRP) beginning July 1993. 3-5 year full–time lectureship appointment in the Department of Mathematics. PhD in Mathematics or Mathematics Education, Master's level background in mathematics, teaching experience or working with math educators at various levels is desired. Responsibilities include organizing and running workshops, seminars, and inservice courses in the Teacher Education Program and one regular undergraduate course in the Mathematics Department; organizing activities to involve Cornell students and faculty in pre-college education; writing grant proposals. Send Curriculum Vitae and three letters of reference to Professor David Henderson, Department of Mathematics, White Hall, Cornell University, Ithaca, New York 14853–7901.
Deadline to apply: 15 January 1993
Cornell is an Affirmative Action, Equal Opportunity Employer.

LENOIR–RHYNE COLLEGE
DEPARTMENT OF MATHEMATICS

Two tenure–track positions, subject to board approval, to begin Fall 1993, at a selective church–related liberal arts college. Math education, applied mathematics desired. Doctorate required. Selection will begin January 1993. Send resume, transcripts, names and phone numbers of references to Robert Spuller, Box 7420, Lenoir–Rhyne College, Hickory, NC 28603.

SUNY COLLEGE OF TECHNOLOGY AT FARMINGDALE
DEPARTMENT OF MATHEMATICS

Fall 1993 anticipated tenure–track vacancies at the assistant professor rank. Teaching responsibilities may include: remedial, technical, college level (through differential equations). Teaching emphasized with scholarship and service expected. Expertise in the use of technology in the teaching of mathematics desired. Minimum qualifications: doctorate in mathematics, statistics, or operations research and some college teaching experience. Salary range is $29,800 to $33,800. Letter of application and resume including the names and addresses of three references must be received by 11 January 1993. Address correspondence to: Dr. Robert V. Mark, Dean, School of Arts and Sciences, State University of New York, College of Technology, Farmingdale, NY 11735. The College is an Equal Opportunity/Affirmative Employer.

MATHEMATICS: FERRIS STATE UNIVERSITY

Two tenure–track Developmental Mathematics teaching positions beginning August 1993. Responsibilities include teaching developmental mathematics courses, primarily arithmetic, in an open–admissions institution, advising students in mathematics and science–oriented curricula, and contributing to the attainment of department, college, and university goals through committee work and special projects. Qualifications: Master's in Mathematics or in Mathematics Education. Additional qualifications include demonstrated interest and success in teaching primarily developmental mathematics for a minimum of two years within the last five years. Preference will be given to candidates having course work in methods of teaching arithmetic and algebra, or experience in working with underprepared students. Personal qualities must include initiative, integrity, patience, ability to work with students and colleagues and a desire to concentrate on the teaching of developmental mathematics. Salary and rank commensurate with qualifications and experience. To receive full consideration, application must be completed by 4 January 1993. Send letter of inquiry describing interest in, and recent experience teaching underprepared students, vita, copies of transcripts, and have three letters of reference sent to: Professor George Wales, Search Committee Chair, Department of Mathematics, Science 118, Ferris State University, Big Rapids, MI 49307. EO/AAE

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Actuarial Department
Newark, New Jersey

Seeking individuals to become technical analysts and work on our casualty reinsurance problems. Casualty reinsurance companies insure insurance companies that provide auto, liability, malpractice, or property coverage. Our analysts are multi–faceted with good skills in problem solving, creativity, communications, PCs, mathematics, statistics, business and actuarial sciences. They are self–motivated, self–learners, and self–starters, can juggle priorities, are team players, can relate to people and can get things done. Our daily work includes: estimating losses on contracts with long reporting delays, using aggregate loss distributions, pricing high limits based on only a small sample of losses, evaluating the time value of money, studying new techniques, programming PC systems to do our work, educating non–math people on key concepts, presenting results in an effective manner to decision makers. There are several challenging development projects underway but our primary focus is on day to day analysis and work. We are a cohesive group of 25 (16 BS/6 MA/3 PhD), (7 FCAS's Fellows of the Casualty Actuarial Society/18 studying to be FCAS's) Outstanding opportunity for those who want exciting practical problems, who want to broadly develop themselves and integrate several disciplines, and who value growth as well as management opportunities. Interested individuals should send a resume, transcript, and a statement focusing on their multi–dimensionality, skills (and evidence of such), and commitment to actuarial work to:

Dr. Ed Weissner, VP., Actuarial Prudential Reinsurance Company, Actuarial Department, 4th Floor, 3 Gateway Center, Newark, New Jersey 07102-4077.

U.S. citizenship or current authorization for full–time work in the U.S. required (Prudential does not sponsor H-1 visas). Applications from NY/NJ area individuals encouraged. Prudential Re is an equal opportunity employer.

Southeastern Oklahoma State University
Position Announcement

Department Chair of Mathematics — A PhD is required for this position. Administrative skills necessary. Rank negotiable. Teaching load is 3–6 hrs. per semester. Demonstrated scholarship and at least 5 years teaching and/or administrative experience at the university level required. Duties include teaching undergraduate mathematics at all levels, scholarly activity, and administrative responsibilities. To apply submit a letter of application, resume, statement of academic philosophy, and three letters of reference to: Personnel Office, Station A, Durant, OK 74701. Application deadline is 1 March 1993.

Assistant Professor/Instructor of Mathematics — A PhD in mathematics is required for the Assistant Professor position (tenure–track). ABD required for the instructor position. Duties include teaching undergraduate mathematics at all levels, student advising, scholarly activities, and committee service. Minorities and women are especially encouraged to apply. To apply submit a letter of application, resume, all university transcripts, a statement of your teaching philosophy, and three letters of reference to: Personnel Office, Station A, Southeastern Oklahoma State University, Durant, OK 74701. Application deadline is 1 March 1993.

Occidental College
Los Angeles, California

Applications are invited to a tenure–track position in the Department of Mathematics at the assistant or associate professor level.

Excellence in teaching and substantial professional achievement are the major expectations. The department is involved in curricular reform and encourages innovative teaching. The normal teaching schedule is 5–6 courses per year. New faculty members are currently released for one course during the initial year. Some institutional support for extended leaves is available.

Occidental College is a selective private college of the liberal arts and sciences with 1,650 undergraduate students, a college faculty of 133, and a mathematics faculty of nine. Occidental is located in northeast Los Angeles, easily accessible to USC, UCLA, and Caltech.

Salary is competitive. An excellent benefits package includes a choice of health care plans, tuition grants for children of faculty, and a mortgage subsidy program.

Completed applications must include a current resume and three letters of reference (at least one evaluating teaching performance and potential). Please include a clear statement of commitment to teaching in a liberal arts college environment as well as indicating professional goals. All materials should be received by 16 February 1993. Address all materials to Faculty Search Committee, Department of Mathematics, Occidental College, 1600 Campus Drive, Los Angeles, CA 90041.

Occidental College is an Equal Opportunity/Affirmative Action Employer and encourages applications from women and ethnic minorities.

Mathematics Department
Kennesaw State College
P.O. Box 444, Marietta, GA 30061

At least one tenure–track position in Mathematics at the level of Assistant Professor beginning in September 1993. Qualifications are a PhD in Mathematics, Statistics, or Mathematics Education with a strong graduate mathematics component required; strong commitment to undergraduate education as well as an interest in scholarly activities. Salary is competitive and commensurate with qualifications and experience. The College is located in Northwest Metro Atlanta, and enrolls over 11,000 day and evening students in undergraduate and graduate programs. The Department of Mathematics has 25 full–time faculty and shares four others with the Department of Computer Sciences. Candidates should send a detailed resume, and arrange for at least three letters of recommendation and graduate transcript to be sent to: Dr. Lewis VanBrackle, Chair, Search Committee, Department of Mathematics, Kennesaw State College, P.O. Box 444, Marietta, GA 30061. All applications received by 1 March 1993 will be considered. However, applications will be accepted until position is filled. EOE/AA.

Miami University, Oxford, Ohio
Department of Mathematics and Statistics

The department anticipates, pending budgetary approval, one or more tenure–track assistant professorships beginning August 1993. Duties include teaching undergraduate and graduate courses, continuing scholarships, and service. Applicants should have a PhD in pure or applied mathematics by 8/93. Applicants in all areas of mathematics will be considered; however, preference will be given to candidates in the areas of optimization, numerical analysis, algebra and complex analysis. Please send vita, graduate transcript and three reference letters to Mathematics Search, Department of Mathematics and Statistics, Miami University, Oxford, Ohio 45056. Screening of applications will begin on 11 January 1993. Women and minorities are encouraged to apply. AA/EOE.

Assistant/Associate Professor of Mathematics

New Mexico Institute of Mining and Technology has a tenure–track position opening starting in August 1993. Applicants must have training in statistics. The position involves a leadership role in statistics curriculum development, teaching undergraduate and graduate courses in probability, statistics, stochastic processes, and operations research, doing research and working with scientists or engineers who use statistics. The successful candidate will be expected to establish a research program, interdisciplinary research is strongly encouraged and funding for the first summer's research program will be provided. Candidates must be able to communicate effectively in written and spoken English. Experience in statistical computer package usage or computer program writing is required. Experience in college teaching and industrial work are desirable. Appointment to tenure–track Assistant Professor is contingent upon possessing a PhD in statistics or related field. Appointment at the Associate Professor level will require, additionally, an established, extensive record of excellence in research, interdisciplinary research work, and the teaching of upper division and/or graduate level courses in statistics.

The department has a strong interdisciplinary program in cooperation with other departments and groups on campus. Areas of application are wide–ranging and include atmospheric physics, biology, computer science, engineering, groundwater hydrology, environmental problems and reservoir simulation. The Institute is a small scientific and engineering school dedicated to excellence in teaching and research. Send applications, resumes and a brief description of proposed research activities, and have three letters of reference sent to New Mexico Institute of Mining and Technology, Human Resources, Wells Hall, Box C-099, Socorro, NM 87801. AAEOE. Deadline is 15 February 1993.

ASSISTANT PROFESSOR

Potsdam College of the State University of New York invites applications for an anticipated tenure–track position in Mathematics, at the rank of Assistant Professor, commencing 1 September 1993. The normal teaching load is 12 hours of undergraduate and beginning graduate level mathematics courses per semester. Applicants must have a PhD in Mathematics (or be near completion). The successful candidate must, in addition, show evidence of being (or having the potential to become) an excellent teacher. The salary will be competitive. Send letter of application, resume, graduate transcripts (copies are acceptable) and three letters of reference to: Dr. J. Parks, Search Committee Chair, Department of Mathematics, Potsdam College, Potsdam, NY 13676. Review of applications will commence 1 February 1993 and continue until the position is filled. Potsdam College is an Equal Opportunity Affirmative Action employer committed to excellence through diversity. We actively seek candidates with significant multicultural experience.

UNIVERSITY OF TENNESSEE AT CHATTANOOGA DEPARTMENT HEAD

The University of Tennessee at Chattanooga invites applications for Head of the Department of Mathematics. A PhD in a mathematical science and at least five years of college mathematics teaching experience are required. Applicants should provide evidence of leadership in curriculum development, teaching, public service and research/scholarly activities. In this primarily undergraduate institution, the faculty is expected to exhibit excellence in teaching while maintaining a strong commitment to research and public service. The mathematics department has 22 faculty members including a Chair of Excellence in Applied Mathematics. Located in a very scenic metropolitan area of 400,000, UTC has a student enrollment of 8100. Send applications with current vita to: Dr. Irene Loomis, Chair of the Search Committee, Dept. of Mathematics, UTC, Chattanooga, TN 37403-2598. Consideration of applications will begin 1 November 1992, and will continue until the position is filled. Women and minorities are encouraged to apply. UTC is an Equal Opportunity Employment/Affirmative Action/Title IX Section 504 Institution.

NORTHWESTERN COLLEGE (IOWA)

Mathematics: Northwestern College (Iowa) announces a tenure–track faculty position for August 1993. Teaching assignments include a range of undergraduate courses including calculus, math education, and math service courses. Requirements include masters degree, and commitment to the Christian faith; teaching experience is highly desirable. Northwestern College is a Christian liberal arts college of 1,000 students. Send resume to Dr. Robert Zweir, Vice President for Academic Affairs, Orange City, Iowa, 51041.

UNIVERSITY OF MONTANA DEPARTMENT OF MATHEMATICAL SCIENCES

The Department of Mathematical Sciences at the University of Montana has openings for four tenure–track Assistant Professorships beginning Fall 1993. One position each in Analysis, Applied Mathematics, and Operations Research is available. It is possible that one of these three appointments may be at the Associate Professor level. A fourth position with major responsibility for coordinating and supervising several freshman level courses is also available. A doctorate in Mathematical Sciences and a commitment to excellence in teaching and research are required for all positions. Research must be in the areas of current faculty members in the department. The department offers B.A., MA, MAT, and PhD degrees in several areas of mathematics. Inquiries or applications (including resume, official graduate transcript, and three letters of recommendation) should be sent to: Don Loftsgaarden, Chair, Department of Mathematical Sciences, University of Montana, Missoula, MT 59812. Phone: (406) 243-4171. Screening of applicants will begin on 15 January 1993 and continue until all positions are filled. The University of Montana is an equal opportunity/affirmative action employer.

MURRAY STATE UNIVERSITY DEPARTMENT OF MATHEMATICS & STATISTICS

Applications are invited for a tenure–track position in mathematics education beginning August 1993.

Candidates must have a doctorate in mathematics or a doctorate in mathematics education with at least a masters degree in mathematics. Evidence of outstanding teaching, a successful record of scholarly activity or the potential for continuing scholarly activity, and a strong commitment to teacher education are required.

Responsibilities include a maximum three course teaching load, continuing research/scholarly activities, and university/departmental service. The person who fills this position will teach a range of mathematics courses, including content and method courses for prospective K–12 teachers, supervise field experience, seek external funding to conduct workshops and seminars for public school teachers, and work in collaboration with public schools to help implement the Kentucky Education Reform Act which was recently enacted by the state legislature.

The application package must include a vita, copies of graduate transcripts, a statement of teaching philosophy. The immigration status of non-U.S. citizens should be indicated on the vita. All applications must meet federal guidelines for working in the U.S. For full consideration, applications must be complete by 15 December 1992. Send the application package and direct three letters of recommendation to:

Dr. Robert Pervine, Search Committee Chair
Department of Mathematics and Statistics
Murray State University
Murray, KY 42701

MSU does not discriminate on the basis of race, color, national origin, sex, or handicap in its programs and activities. For information contact the MSU Affirmative Action Office, 502/762-3155.

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Membership Manager

PS Form 3526, January 1991

GETTYSBURG COLLEGE

Gettysburg College invites applications for a tenure–track assistant professor position in mathematics beginning September 1993. A PhD in mathematics, promise of excellence in teaching, and a commitment to continued scholarship are essential.

Gettysburg College is a highly selective liberal arts college of about 2000 students in a beautiful and historic area of south central Pennsylvania. It is conveniently located, within an hour and a half drive of the Washington–Baltimore area.

Send letter of application stating teaching and scholarship interests and goals, curriculum vitae, and the names of three references (at least one of who can address teaching effectiveness) to: James P. Fink, Chair, Department of Mathematics and Computer Science, Gettysburg College, Gettysburg, PA 17325. Formal evaluation of applicants will begin on 20 January 1993 and will continue until the position is filled. Gettysburg College is an Equal Opportunity/Affirmative Action employer. Women and minority candidates encouraged to apply.

FACULTY VACANCY ANNOUNCEMENT
BOWLING GREEN STATE UNIVERSITY
FIRELANDS COLLEGE

Firelands College of Bowling Green State University invites applications for a full–time tenure–track position in MATHEMATICS within the Department of Natural and Social Sciences at the rank of Assistant Professor beginning August 1993. Responsibilities for this position include teaching 12 hours per semester in the areas of college algebra and trigonometry, calculus, elementary statistics, mathematics for elementary education majors, and developmental mathematics (pre–college algebra). Also, the chosen candidate is expected to participate in departmental and college committees, and to engage in other service activities and scholarly productivity. All candidates *must* possess a doctorate in mathematics or mathematics education. All candidates *must* exhibit a strong preference and aptitude for teaching lower–level undergraduate students, especially those with weaker mathematical backgrounds. A commitment to interdisciplinary approaches and innovative teaching practices *must* be evident. A thorough record of exemplary and successful teaching performance in required. The salary for this position is $28,000 – $30,000, dependent upon experience.

Firelands College is a branch college of Bowling Green State University, offering courses for associate degree and pre-baccalaureate degree programs, as well as providing a cultural center for surrounding communities. Many of Firelands College's 1500 students are non–traditional in nature, prompting the need for unique approaches to instruction. Thus, the College is committed to excellence in teaching, while beign supportive of research and creativity. Firelands College is located on a 216 acre site on the Lake Erie shore in Huron, Ohio, and is accessible to the cultural and recreational opportunities of both Cleveland and Toledo.

Individuals interested in being considered for this position are required to send a letter of application and resume/vita, and to initiate whatever action is necessary to ensure that **official transcripts** of all undergraduate and graduate courses, and at least three recent (dated within the past year) letters of reference are sent to: Office of the Dean, Firelands College, 901 Rye Beach Road, Huron, OH 44839 by **1 February 1993**. Proof of authorization for employment in the U.S. is also required. Firelands is an Affirmativs Action/Equal Opportunity Employer and encourages women and minorities to apply.

NUMERICAL ANALYSIS POSITION
DEPARTMENT OF MATHEMATICS
SOUTHERN ILLINOIS UNIVERSITY AT CARBONDALE
CARBONDALE, ILLINOIS 62901

Applications are invited from qualified candidates for a tenure–track position at the assistant professor level beginning on 16 August 1993. PhD in mathematics with specialization in numerical analysis required. Candidates must have demonstrated excellence in research or potential for such. Evidence of teaching effectiveness is required (foreign applicants **must** provide evidence of ability to teach in English effectively). Send letter of application, resume, and three letters of recommendation to:

Numerical Analysis
c/o Ronald B. Kirk, Chair
Department of Mathematics
Southern Illinois University at Carbondale
Carbondale, Illinois 62901

The closing date for applications is 10 December 1992, or until the position is filled. SIUC IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER. Women and minorities are particularly encouraged to apply.

GUILFORD COLLEGE

Department of Mathematics: Two–year temporary position at a selective Quaker affiliated liberal arts college of approximately 1600 students. Seeking applicants with enthusiasm for teaching service courses (especially elementary statistics) and courses in the major; appreciation for the liberal arts; interest in applied mathematics, computing, and research with undergraduates; and continuation of personal research. PhD preferred. Send letter, vita, transcripts, and three recommendations to Kathrynn Adams, Academic Dean, Guilford College, Greensboro, NC 27410. Deadline: 15 January 1993. Women and minorities urged to apply. EOE/AA.

UNIVERSITY OF LOUISVILLE
DEPARTMENT OF MATHEMATICS

The Department of Mathematics is seeking applications for an entry–level, tenure–track appointment. Candidates must present evidence of excellence, or potential for excellence, in teaching and research. The department is primarily looking for candidates with expertise in numerical analysis, but specialties complementing other areas of analysis already represented in the department will be considered. These include partial differential equations, functional equations, classical real analysis and harmonic analysis. Primary teaching responsibilities include courses at all levels, including general education courses. PhD preferred, ABD considered. Candidates should send a letter of application, curriculum vitae, and

Art and Mathematics Conference (AM93)
STATE UNIVERSITY OF NEW YORK, ALBANY

AM93 is an international interdisciplinary conference relating art and mathematics. The emphasis is on visualization with examples from architecture, geometry, graphics, quilts, painting, sculpture, and topology. Speakers will include Tom Banchoff, John Conway, Pam Davis, Stewart Dickson, Michele Emmer, Helaman Ferguson, Zvi Hecker, Clement Meadmore, Tony Milkowski, Charles Perry, Rhonda Roland Shearer, and Kenneth Snelson. There will be panel discussions, a slide and video registry, and space available for displays. Registration Information: Nat Friedman, Department of Mathematics, SUNY–Albany, Albany, NY 12222, FAX (518)442–4731, email: artmath@math.albany.edu, Phone (518)442–4621.

three letters of recommendation by 1 February 1993 to Dr. Robert B. McFadden, Chair, Department of Mathematics, University of Louisville, Louisville, KY 40292. African Americans, women, and other minorities are encouraged to apply. The University of Louisville is an AA/EEO Employer.

TENNESSEE TECHNOLOGICAL UNIVERSITY
DEPARTMENT OF MATHEMATICS
COOKEVILLE, TN 38505

Two tenure–track Asst. Prof. positions to begin August 1993. PhD in Mathematical Sciences, evidence of excellent teaching ability/potential & strong promise of research required. Analysis preferred for one position. Duties include teaching grad. & undergrad. courses, directing master's students, engaging in research activities & participating in course development. Initial review of applications to begin 1-15-93; applications accepted until positions filled. Transcripts, curriculum vitae & three letters of recommendation should be sent to: Dr. J.T.B.Beard Jr., Chairperson, Search Committee. TTU will only hire U.S. citizens and aliens lawfully authorized to work in the U.S. Qualified women, minorities & disabled individuals strongly urged to apply. AN AA/EEO/ADA EMPLOYER.

PRESBYTERIAN COLLEGE
DEPARTMENT OF MATHEMATICS

Tenure–track position at the level of assistant professor to teach all levels of mathematics in a liberal arts college, beginning August 1993. Completion or near completion of PhD in mathematics required. Any specialization considered. Upon receipt of a letter indicating your interest in the position, you will be sent more information about the college, the position, and how to complete your application. Send letter to Dr. Joel L. Jones, Presbyterian College, Clinton, SC 29325. Presbyterian College is affiliated with the Presbyterian Church (USA).

LUTHER COLLEGE

Luther College invites applications for a tenure–eligible position as assistant professor of mathematics beginning late August 1993. PhD preferred; ABD minimum requirement in mathematics with core in algebra. Under the college's 4-1-4 academic calendar, the teaching load is comprised of three courses per semester and one course in each of two out of three January Terms. Luther College is seeking persons committed to excellence in teaching and to professional and scholarly activity in mathematics. Luther College is a liberal arts college of the Evangelical Lutheran Church in America and maintains close ties with that church; faculty members at Luther College are expected to be willing to work with colleagues on sustaining its strong liberal arts tradition in the context of Christian higher education. Review of applications begins 10 December 1992, and continues until the position is filled. All correspondence, including letter of application, three letters of reference, transcripts of academic work, and placement files should be sent to Dr. George Trytten, Head, Department of Mathematics, Luther College, Decorah, Iowa 52101. Telephone: 319/387-1174; FAX 319/387-1080. An AA/EEO employer; minorities and women are encouraged to apply.

CARLETON COLLEGE

Carleton College Department of Mathematics and Computer Science has a tenure–track position beginning September 1993. A PhD in computer science or mathematics is required. The successful candidate will teach two courses per term, three terms per nine–month year, including upper–level computer science. Teaching excellence is the most essential consideration. Review of applications will begin in mid–December and will continue until the position is filled. Affirmative Action/Equal Opportunity Employer; applications specifically invited from women and members of minority groups. Send letter of application, resume, graduate transcript(s), and three letters of recommendation to Loren Haskins, Chair, Department of Mathematics and Computer Science, One North College Street, Northfield, MN 55057-4025 (email: lhaskins@carleton.edu). At least one letter should specifically address teaching. Carleton College is a highly selective liberal arts college 35 miles south of Minneapolis/St. Paul. Department has 12 full–time members. Computing resources available to department include NeXT's Mac II's, PCs DEC microvax, Raster Tech 3/85 workstation, transputer–equipped parallel processing stations, and a central VAX cluster.

HARVEY MUDD COLLEGE
DEPARTMENT OF MATHEMATICS
CLAREMONT, CA 91711

The Mathematics Department of Harvey Mudd College solicits applicants for a tenure-track Assistant Professorship in an area bridging mathematics and computer science. A strong commitment to and promise of excellence in teaching are essential. Applicants should be active in a research area such as Parallel or Combinatorial Algorithms, Numerical Analysis and Algorithms, Automated Reasoning, or Computational Geometry. Applicants must be able to teach broadly within mathematics and the mathematical aspects of computer science and to work well with others in developing departmental programs.

Harvey Mudd College is a highly selective undergraduate institution. Our students major in mathematics, computer science, biology, chemistry, engineering, or physics. A one–year course in calculus is a prerequisite for admission to the college. PhD degrees have been earned by 40.7% of the college's pre–1980 graduates, the highest percentage in the nation. The college has an enrollment of 630 and is associated with four other undergraduate colleges and a graduate school in Claremont, forming an academic community of about 5,000 students. The college has 12 mathematics faculty and the Claremont Colleges combined have a total of 48 Mathematics and Computer Science faculty. An excellent network of modern computer workstations is available.

Harvey Mudd College is an affirmative action, equal opportunity employer. Minority and women candidates are especially encouraged to apply. Preference will be given to applications received by 10 January 1993. Applicants should send a curriculum vitae, a description of their research, and arrange to have three letters of reference sent directly to:

Search Committee
Department of Mathematics
Harvey Mudd College
Claremont, CA 91711

LOUISIANA SCHOLARS' COLLEGE
NORTHWESTERN STATE UNIVERSITY

Tenure–track asst. prof. for August 1993; will devise and teach math and interdisciplinary courses at all levels. An autonomous division of NSU, LSC is Louisiana's four-year honors college of the liberal arts. Students complete a rigorous Common Curriculum based largely on seminar discussions of primary texts in the arts and sciences; they then pursue individually designed concentrations in the sciences, humanities, or arts. All seniors undertake a year–long research project. Class sizes <25. Research fields open. PhD required. LSC has no departments; applicant will interact with colleagues from other fields in the liberal arts. New courses linking math to these fields welcomed. Send letter detailing the teaching and research interests you could bring to this undergraduate honors curriculum; CV; transcripts; and 3 reference letters to the Director, Louisiana Scholars' College, NSU, Natchitoches, LA 71497 by 10 January 1993. AA/EEO.

COLORADO COLLEGE

Colorado College, Department of Mathematics, Colorado Springs, CO 80903. Tenure–track position in mathematics to begin 29 August 1993. PhD expected. Assistant Professor is preferred, but all ranks will be considered. All fields of specialization are welcome, but a background in analysis or applied math and an ability to teach undergraduate computer science is desirable. Colorado College, a leading national liberal arts college, is actively seeking greater diversity in its faculty and strongly encourages those from groups under–represented in the mathematical professions to apply. The Department of Mathematics values both excellence in teaching undergraduate mathematics and vigorous mathematical scholarship. Candidates should send a letter of application describing both your commitment to teaching and your mathematical interests, curriculum vitae, a complete set of transcripts, and arrange to have three letters of recommendation (at least one addressing teaching) to Fred Tinsley at the above address. Applications received by 1 January 1993 are guaranteed of full consideration.

SUNY–GENESEO

Position available September 1993. Instructor/Assistant Professor, two–year, tenure–track. Qualifications: PhD, teaching experience, scholarly growth. Send resume, three letters of recommendation, transcripts to: Donald Thrasher, Chair, Department of Mathematics, 1 College Circle, Geneseo, NY 14454. Closing date: 1 February 1993. (AA/EEO) Women and minorities are encouraged to apply.

SOUTHWEST MISSOURI STATE UNIVERSITY

Southwest Missouri State University/Department of Mathematics. An Assistant Professor position in Mathematics Education is anticipated beginning 20 August 1993. This is a tenure–track position. Applicants must have a PhD or EdD in Mathematics Education, evidence of excellence in teaching, and a commitment to continued research. For this position preference will be given to applicants with research interests compatible with those of the current faculty. Demonstrated proficiency in both spoken and written English is required. Duties include teaching, research, and service. Send application (resume, three letters of reference, graduate transcripts, and a letter of interest) to Dr. M. Michael Awad, Head, Department of Mathematics, Southwest Missouri State University, Springfield, MO 65804–0094. To ensure consideration, application materials should be received by 1 February 1993. AA/EEO.

LAKE FOREST COLLEGE
DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

Applications are invited for a continuing appointment in Mathematics at the Assistant Professor level, starting in the Fall of 1993. Future tenure consideration is possible. We seek candidates with a PhD, a commitment to excellence in teaching in a quality liberal arts environment, and an active interest in mathematics research. The teaching load is three courses per semester.

Lake Forest College offers the BA degree in eighteen departments and eleven interdisciplinary fields. The college stands on a wooded, 107 acre campus in the city of Lake Forest on Chicago's North Shore, just 30 miles from the Chicago Loop. The Department of Mathematics and Computer Science offers majors in both disciplines and has 7 full time faculty members. Applications from minorities and women are actively encouraged. Applicants should send a curriculum vitae and arrange to have three letters of reference and a graduate transcript sent to:

Edward W. Packel, Chairperson
Department of Mathematics and Computer Science
Lake Forest College
555 North Sheridan Road
Lake Forest, Illinois 60045–2399

Deadline for applications is 20 December 1992, when review of applications will begin.

ASSISTANT PROFESSOR OF MATHEMATICS
UNIVERSITY OF NORTHERN IOWA

Tenure–track position to aid in teaching general education courses and to support our majors and graduate students. Applications and nominations are invited for a position at the assistant professor level. The department seeks to hire a candidate with a PhD in Analysis. Candidates with expertise in any area of modern analysis will be considered, however; individuals with specialization in Functional Analysis are preferred. Appointment is for the academic year beginning in August 1993. Salary is very competitive; fringe benefits are excellent. Application screening begins 15 February 1993 and will continue until an appointment is made. For more information contact Gregory Dotseth, Mathematics Department, University of Northern Iowa, Cedar Falls, IA 50614 (319) 273–2397 dotseth@math.uni.edu.

An affirmative action/equal opportunity educator and employer.

BOSTON COLLEGE
DEPARTMENT OF MATHEMATICS
CHESTNUT HILL, MA 02167

One tenure–track assistant professorship to begin in September 1993. Candidates should have completed or nearly completed the PhD and have strong potential and motivation in both research and undergraduate teaching. Teaching load will be five to six courses per year. Applicants should submit a statement of professional interests and goals, a curriculum vitae, and have at least three letters of recommendation sent which address the candidate's teaching and research. For full consideration completed applications should be received by 31 December 1992. Boston College is an Affirmative Action/Equal Opportunity employer. Contact Person: Chair, Search Committee; email address: MATHDEPT@bc.edu.

Math Faculty Positions. Pennsylvania State University at Erie, The Behrend College. The Division of Science seeks to fill two tenure–track positions

in mathematics starting Fall Semester 1993. Both positions are at the level of Assistant Professor. We are interested in filling one of the positions in statistics/operations research and the other in applied analysis, although applications in other fields will also receive consideration. Behrend College places strong emphasis on undergraduate teaching. Candidates must have an earned doctorate, and commitments to excellence in teaching and research; some teaching experience preferred. Applicants should send a resume, reprints of published papers, official transcripts, and at least three reference letters to the Chair, Math Search Committee, Penn State–Behrend College, Division of Science, Dept. MATH–F, Station Road, Erie, PA 16563-0203. Application deadline is 31 January 1993, or until the positions are filled.
An Affirmative Action/Equal Opportunity Employer. Women and Minorities Encouraged to Apply.

ALMA COLLEGE
DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE
ALMA, MICHIGAN 48801-1599

Tenure–track position in mathematics for Fall 1993. Candidates should enjoy teaching a wide variety of undergraduate courses, be committed to excellence in teaching, and possess a PhD. Duties include advising, assisting with curriculum revisions, supervising student projects, and active scholarship. Alma College is a selective, private liberal arts college known for the quality of its programs in the sciences. Applications from women and minorities are particularly welcome. AA/EOE. Closing date is 21 January 1993. Send cover letter, resume, copy of graduate transcript, and three letters of recommendation including evaluation of teaching to:
M. A. Nyman, Chair, Mathematics and Computer Science Department, Alma College, Alma, Michigan 48801-1599

CHOATE ROSEMARY HALL
DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE
CHAIR

Choate Rosemary Hall, a coeducational independent boarding school (grades 9-12) with 800 boarding and 200 day students from 41 states and 38 countries, is seeking a Chair of the Department of Mathematics and Computer Science, beginning in September 1993. Applicants should be well versed in the NCTM Curriculum & Evaluation Standards & Professional Teaching Standards and be able to lead a department of approximately 25 faculty who teach courses ranging from Algebra I to Multivariable Calculus as well as a wide variety of electives including probability, statistics, logic, and dynamical systems. Computer facilities include IBM and Macintosh labs as well as graphing calculators are used extensively. Candidates should submit a letter of application, resume, transcript, and two letters of recommendation by 10 February 1993 to G. Edmondson Maddox, Dean of Faculty, Choate Rosemary Hall, P.O. Box 788, Wallingford, CT 06492. Minority and female candidates are encouraged to apply.

PHILLIPS ACADEMY
ANDOVER, MA 01810
DEPARTMENT OF MATHEMATICS

Phillips Academy, an independent national and international residential high school for 1200 able college-bound students maintains high academic standards. Approximately 70% of the faculty hold M.A. and PhD degrees. The school desires and supports multi-cultural curriculum and a diverse faculty.
The Mathematics Department seeks a highly energetic teacher with a master's or doctor's degree who enjoys working with students and who wants to teach algebra, geometry, calculus, and discrete mathematics, as well as think about curricular questions and how to use computers in the teaching of mathematics. A small number of the most advanced students take mathematics through vector calculus and linear algebra. Applicants need to be enthusiastic about living in a residential school that thrives on the challenges of diversity. Teaching at Andover includes advising student activities and coaching sports at an appropriate level.
Applicants should submit a resume and a letter outlining how they foresee contributing to the school. Letters should be addressed to the **Dean of Faculty.** (EOE)

THE JOHNS HOPKINS UNIVERSITY
Department of Mathematical Sciences

Applications are invited for 3 anticipated faculty positions within the areas of

- **Numerical Linear Algebra**
  (Senior applicants preferred)
- **Statistics**
- **Operations Research**
- **Applied Discrete Mathematics**

Selection is based on demonstration and promise of excellent research, teaching and innovative applications.
Minorities and women are encouraged to apply. The Johns Hopkins University is an Affirmative Action/Equal Opportunity Employer.
Applicants are asked to furnish a curriculum vitae, transcripts (junior applicants only), reprints (if available), a letter describing professional interests and aspirations, and to arrange for three letters of recommendation to:
Prof. John C. Wierman, chair
Department of Mathematical Sciences
220 Maryland Hall
The Johns Hopkins University
Baltimore, Maryland 21218-2689

Applications are requested by 15 January 1993. Applicants whose primary research is in algebra, analysis, geometry, logic, number theory, or topology will not be considered.

OBERLIN COLLEGE

A one-year position starting September 1993. Responsibilities include teaching undergraduate courses (5/year). All fields considered but preference given to candidates with experience and/or expertise in **statistics**. Qualifications required include the PhD degree (in hand or expected by Fall 1993). Candidates must demonstrate potential excellence in teaching. Please send letter of application, curriculum vitae, academic transcripts, and three letters of reference to: **Michael Henle, Department of Mathematics, Oberlin College, Oberlin, OH 44707** by 8 January 1993. Applications received afterwards may be considered until the position is filled. AA/EOE.

Darthmouth College
John Wesley Yung Research Instructorship in Mathematics

The John Wesely Young Research Instructorship is a teo year post-doctoral appointment for promising new or recent PhD's whose research interests overlap a department member's. Current departmental interests include areas in algebra, analysis, algebraic geometry, combinatorics, computer science, differential geometry, logic and set theory, number theory, probability and topology. Teaching sutied of four ten-week courses spread over two or three quaters typically include at least one ocurse in the isntructor's speciality and include elementary, advanced and (at instructor's option) graduate courses. Nine-month salary of $34,000 supplemented by summer (resident) research stipend of $7,556 (two-ninths). Send letter of application, rèsumè, graduate transcript, thesis abstract, description of other research activities and interests if appropriate, and 3 or preferably 4 letters of recommendation (at least one should discuss teaching) to Phyllia A. Bellmore, Mathematics and Computer Science, 6188 Bradley Hall, Hanover, NH 03755-3551. Applications receives by 15 January 1993 receive first consideration: applications will be accepted until position is filles. Dartmouth College is committes to affirmative action and stringly encouraged applications from minorities and women.

SHIPPENSBURG UNIVERSITY
DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

Two tenure–track positions at the assistant professor level for September 1993.
MATHEMATICS – PhD in Mathematics required. Candidates must demonstrate ability to teach the undergraduate and graduate mathematics courses offered by the department and give evidence of a commitment to a technology–based education. The candidate's experience and expertise in computer science will also be considered. The primary responsibilities are to teach undergraduate courses in department, graduate mathematics courses, with a maximum of 24 credits per year, advise students, conduct research and contribute to the academic life of the department and the university. Applications will be reviewed beginning 1 February 1993; apply to the Mathematics Search

Committee.
MATHEMATICS EDUCATION – Doctorate in Mathematics or Mathematics Education required. Research interest in mathematics education with a minimum of the equivalent of a master's degree in a content area taught in the department. Candidates must demonstrate ability to teach secondary mathematics education courses and supervise student teachers. The candidate's ability to teach geometry and use technology in the classroom will also be considered. The primary responsibilities are to teach undergraduate courses in departmental, graduate mathematics education courses, with a maximum of 24 credits per year, advise students, conduct research and contribute to the academic life of the department and the university. Applicants will be reviewed beginning 1 March 1993; apply to the Mathematics Education Search Committee.
Candidates who will be completing their PhD within two years will be considered, but a doctorate is required for granting tenure. The positions require a commitment to excellence in teaching and effective communication skills, as well as experience or potential in research and academic service.
The Department of Mathematics and Computer Science includes 25 full–time faculty members. There are approximately 150 computer science majors and 170 mathematics and mathematics education undergraduate majors in the department and 140 graduate students. The department offers graduate education. The university computer equipment includes a Unisys 220 mainframe and a Digital Equipment Corporation VAX computer while departmental laboratories include a UNIX Laboratory, an Interfacing Laboratory and Microcomputer Laboratory, containing various microcomputers and workstations; all of which are networked to provide access locally and around the globe via BITNET and INTERNET.
Candidates must submit copies of graduate and undergraduate transcripts, publications (if any), three letters of recommendation from persons familiar with candidate's professional competence, and other appropriate information which demonstrates candidate's satisfactory qualifications. Incomplete applications will not be considered. Send applications to the appropriate **Search Committee, Department of Math and Computer Science, Shippensburg University, Shippensburg, PA 17257 (717) 532-1431.** Applications will be received until the positions are filled.
Shippensburg University is an Equal Opportunity/Affirmative Action Employer.

WEST CHESTER UNIVERSITY MATHEMATICS EDUCATION

West Chester University's Department of Mathematics and Computer Sciences invites applications for a tenure–track Assistant or Associate Professor in Mathematics Education beginning September 1993 to teach pre– and in–service content and methods courses, as well as other mathematics services courses. Doctorate with the equivalent of a Master's in Mathematics required. Must have teaching experience at the pre–college level or pre–service mathematics and demonstrated teaching experience. Preference given to candidates with elementary/middle school experience and to those with demonstrated ability in educational research and grant–writing in K–8 mathematics education.
Send vita, transcripts, and three letters of reference. postmarked by 26 March 1993 to: **Dept. of Mathematics/Computer Science, Chairperson, West Chester University, West Chester, PA 19383.** AA/EOE. Women and minorities are encouraged to apply.

UNIVERSITY OF SOUTH CAROLINA DEPARTMENT OF MATHEMATICS

The Department of Mathematics invites applications for expected tenure–track faculty positions for Fall 1993, at all ranks. Applications in all areas of mathematics will be considered. Research is supported by excellent inhouse library and computing facilities. The PhD degree or its equivalent is required. Appointments will be consistent with the Department's commitment to excellence in research and in teaching at the undergraduate and graduate levels. A detailed resume, containing a summary of research accomplishments and goals, and four letters of recommendation should be sent to:

Dr. George F. McNulty, Chairman
Department of Mathematics
University of South Carolina
Columbia, SC 29208

The University of South Carolina is an Affirmative Action/Equal Opportunity Employer.

DARTMOUTH COLLEGE

The Department of Mathematics and Computer Science has an opening for a tenure–track Assistant Professor in Differential Geometry, with initial appointment in the 1993-1994 academic year. A candidate for the position must be committed to outstanding teaching at all levels of the undergraduate and graduate curriculum and must give evidence of a well regarded research program that shows real promise for the future. Candidates with several years of experience should in addition be ready to direct PhD theses.
To create an atmosphere supportive of research, Dartmouth offers new faculty members grants for research-related expenses, a quarter of sabbatical leave for each three academic years in residence and flexible scheduling of teaching responsibilities. The teaching responsibility in mathematics if four courses spread over two or three quarters. The department encourages good teaching with a combination if committed colleagues, and bright, responsive students.
Though first priority is to appoint a differential geometer, our second priority is in algebra. Exceptional circumstances could lead to making the appointment in some third field. To apply, send a letter of application, curriculum vitae, and a brief statement of research results and interests. Also arrange for four letters of reference to be sent, at least one of which addresses teaching, and, if the applicant's native language is not English, the applicant's ability to use English in a classroom. All application materials should be addressed to Phyllis Bellmore, Recruiting Secretary, Mathematics and Computer Science, 6188 Bradley Hall, Dartmouth College, Hanover, NH 03755-3551
Applications completed by 1 February will receive first consideration. Dartmouth is committed to Affirmative Action and encourages applications from African Americans, Asian Americans, Hispanics, Native Americans, and women. Inquiries about the progress of the selection process can be directed to Richard E. Williamson, Recruiting Chair.

MATHEMATICS

Applications are invites for a tenure–track position at the rank of Assistant Professor in the Department of Mathematical Sciences, Ball State University, effective August 1993. A doctorate in one of the mathematical sciences, completed by 23 August 1993, and evidence of successful college or university teaching are required. Demonstrated research potential is preferred. Salary and benefits are competitive and commensurate with qualifications. Duties include teaching, predominately at the undergraduate level, mathematical research, and professional service. The Department of Mathematical Sciences includes faculty in pure and applied mathematics, statistics, actuarial science, and mathematics education. The department offers a range of academic programs leading to BA, BS, MA, MS, and MAE degrees in these areas. Outstanding candidates in any area of the mathematical sciences will be considered, although preference will be given to candidates whose research interests are compatible with those of the present faculty or with departmental needs. Candidates with interests in differential equations or number theory are encouraged to apply. Applications from women and minorities are strongly encouraged. Initial evaluation of applications will begin in December and will continue until the position is filled. Interested applicants should request a departmental application form from: Dr. Norman K. Lee, Chair, Faculty Search Committee, Department of Mathematical Sciences, Ball State University, Muncie, IN 47306-0490, email: OONKLEE@LOE.BSUVC.BSU.EDU.
Ball State University is an Equal Opportunity, Affirmative Action Employer and is strongly and actively committed to diversity within its community.

WILLIAMS COLLEGE
DEPARTMENT OF MATHEMATICS
WILLIAMSTOWN, MASSACHUSETTS 01267

One or possibly two anticipated positions, one of them preferably in statistics, probably at the rank of assistant professor, for Fall 1993. Strong commitment to both teaching and scholarship is essential.
Please have a vita and three letters of recommendation on teaching and research sent to Hiring Committee. Formal evaluation of applications will begin 15 November 1992, and continue until the positions are filled. AA/EOE.

Calendar

National MAA Meetings

13-16 January 1993 Seventy-sixth Annual Meeting, San Antonio, Texas (Board of Governors, 12 January 1993)

15-19 August 1993 Sixty-eighth Summer Meeting, Vancouver, British Columbia (Board of Governors, 14 August 1993)

12-15 January 1994 Seventy-seventh Annual Meeting, Cincinnati, Ohio (Board of Governors, 11 January 1994)

Sectional MAA Meetings

Allegheny Mountain Penn State-Behrend Campus, Erie, PA, 16-17 April 1993

Eastern PA & Delaware Muhlenberg College, Allentown, PA, 14 November 1992, Villanova University, Villanova, PA, Spring 1993

Florida University of Central Florida, Orlando, FL, 5-6 March 1993

Illinois St. Mary's College, Notre Dame, IN, 23-24 April 1993 (Joint meeting with Indiana & Michigan Sections)

Indiana Indiana University-East, Richmond, IN, 17 October 1992, 23-24 April 1993 (Joint meeting with Illinois & Michigan Sections)

Intermountain University of Utah, Salt Lake City, Utah, 9-10 April 1993

Iowa Luther College, Decorah, IA, 16 - 17 April 1993

Kansas Emporia State University, Emporia, KS, 19-20 March 1993

Louisiana-Mississippi University of Southern Mississippi, Biloxi, MS, 5-6 March 1993

Maryland-District of Columbia-Virginia Coppin State College, Baltimore, MD, 13-14 November 1992, Christopher Newport College, Newport News, VA, 16-17 April 1993

Metropolitan New York York College, Jamaica, NY, 1 May 1993

Michigan St. Mary's College, Notre Dame, IN, 23-24 April 1993 (Joint meeting with Indiana & Illinois Sections)

Missouri Westminister College, Fulton, MO, 2-3 April 1993

Nebraska University of South Dakota, Vermillion, SD, 16-17 April 1993

New Jersey Drew University, Madison, NJ, 14 November 1992, Middlesex County College, Edison, NJ, 20 March 1993 (Joint meeting with MAANJ & MATYCNJ)

North Central Moorhead State University, Moorhead, MN, 23-24 October 1992, Riverwood Conference Center, Monticello, MN, 30 May—1 April 1993

Northeastern Trinity College, Hartford, CT, 20-21 November 1992, University of Massachusetts/Dartmouth, No., Dartmouth, MA, 11-12 June 1993

Northern California University of California, Berkeley, CA, 20 February 1993

Ohio Xavier University, Cincinnati, OH, 30-31 October 1992, Kent State University, OH, 16-17 April 1993

Oklahoma-Arkansas Oral Roberts University, Tulsa, OK, 26-27 March 1993

Pacific Northwest University of Puget Sound, Tacoma, WA, 6 March 1993

Rocky Mountain Colorado School of Mines, Golden, CO, 2-3 April 1993

Seaway Cornell University, Ithaca, NY 13-14, November 1992, SUNY at Binghamton, Binghamton, NY, 23-24 April 1993

Southeastern University of South Carolina-Conway, Conway, SC, 2-3 April 1993

Southwestern New Mexico Institute of Mining & Technology, Scorro, NM, 16-17 April 1993

Southern California University of Southern California, Los Angeles, CA, 7 November 1992, California State University, San Marcos, CA, 6 March 1993

Texas Abilene Christian University, Abilene, TX, 1-3 April 1993

Wisconsin University of Wisconsin- La Crosse, La Crosse, WI, 10 October 1992, University of Wisconsin - Fox Valley, Menasha, WI, 16-17 April 1993

Other Meetings

23-25 April 1993 The 1993 Annual Meeting of New York State Mathematics Association of Two-Year Colleges (NYSMATYC) will be held at the Radison Hotel, Utica Centre, Utica, NY. For additional information contact: Judy Cain, NYSMATYC President-Elect, Tompkins Cortland Community College, 170 North Road, Dryden, NY 13053.

2-4 July 1993 The Global Awareness Society International Annual Meeting, "Global Interdependence" at the Marriott Marquis in New York City. Abstract deadline is December 1 1992. For additional information please contact Jim Pomfret, Department of Mathematics and Computer Science, Bloomsburg University, Bloomsburg, PA 17915.

4-24 August 1993 Canadian Mathematical Society Annual Meeting. "Mathematical Quantum Theory", Vancouver, Canada.

22 - 24 April 1993 Twenty-ninth Biennial Kappa Mu Epsilon (KME) National Convention, Niagara University, New York. For additional information contact harold Thomas, Pittsburg State University, Pittsburg, Kansas 66762, (316) 231-7000.

29-30 January 1993 The Mathematics Department of Montgomery County Community College and Texas Instruments are co-sponsoring a two-day, faculty development institute on using the graphing calculator in teaching precalculus and calculus courses. For further information contact Dr. Roseanne Hofmann, Mathematics Department, Montgomery County Community College (215) 641-6405.

The Mathematical Association of America
1529 Eighteenth Street, NW
Washington, DC 20036-1385

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