

7/2, 1975

I would like to see position papers and discussions on the following subjects at ODE Workshop II. Where I felt it appropriate, I have indicated advocates of various views. These advocates should be asked to prepare position papers (or written statements) and to make presentations at the time of their meeting. I am willing to prepare notes after the workshop, and if there are no objections will plan to do so.

I. DEPACK - SHIMM'S SYSTEMS COLLECTION OF ODE SOLVERS (SHIMM)

General

- A. TYPE OF PROBLEMS THAT CAN BE SOLVED
- B. TESTING PROCEDURE & CERTIFICATION
- C. APPEARANCE OF CODE TO USERS

II. OWN VARIABLES (JIM BOYLE)

- A. DESCRIPTION OF OWN VARIABLE
- B. PITFALLS OF OWN VARIABLES IN FORTRAN
- C. USE OF DATA STATEMENTS,
COMMON BLOCKS, ASSIGNMENT STATEMENTS,
D. COMMON BLOCKS

III. COMPLICATED, CUMBERSOME CALLING SEQUENCES
VERSUS INFLEXIBLE, ANTI-OBJECT CODE
COMMON BLOCKS

A. PRO COMMON BLOCK--TIMING, CONVENIENCE,
DESCRIPTIVE VARIABLE NAMES,
DATA BLOCK SUBPROGRAMS, INFLEXIBILITY,
TIMING TESTS. (JIM COBY, ALAN HUNTER)

B. PRO - HAIRY CALL SEQUENCES --
CONVENIENCE, LOAD MODULE ADVANTAGES,
NON-DESCRIPTIVE VARIABLE NAMES.
(JIM BOYLE, TOM HULL)

IV. UNIFORM INTERFACES FOR CODE TO
BE TESTED, OR WHICH LOOK LIKE
TO TESTING PROGRAMS. Full

V. PORTABILITY -- WHAT IS IT REALLY? Preprocessors,

a) EISPACK Approach

b) IMSL Approach

c) Other Approaches (George
Byrne and others.)

VI. TEST PROBLEMS of Two types --

STIFF AND NON STIFF

- A. HOW TO CONVINCE THE USER A CODE CAN OR CAN NOT SOLVE HIS PROBLEM WITHOUT REALLY TRYING...
NON-SOPHOMORIC TEST PROBLEMS.

(FRED KROGH, TOM HULL OR OTHER TORONTO MAN, ALAN HINDERTSON, LARRY SHAMPINE OR COBY [see also I.B])

- B. A BAD TEST SET (GEORGE BYRN)

VII. ERROR NORMS AND ERROR CRITERIA.

- A. ROOT MEAN SQUARE ERROR (THE GOOD ONE)

- B. L^∞ NORM (TOM HULL & LARRY SHAMPINE)

- C. CONVEX COMBINATION OF RELATIVE AND ABSOLUTE ERROR (TOM HULL, LARRY SHAMPINE, JIM COBY)

VII ARGONNE'S ROLE IN OLFTRAK

A. ARGONNE RESOURCES FOR IMMEDIATE FUTURE - Less than 6 months.

(a) MANPOWER (WHO IS ARGONNE?)

(a) MONEY

B. ARGONNE RESOURCE PROJECTIONS --

More than 6 months

C. ARGONNE (WHO?) AS A MANAGER OF A CONSORTIUM OF MORE-OR-LESS TEST SITES -- QUALITY VERSUS TIME

(GANNETT STUDIES THE ONE)

D. OTHER SOURCES FOR OLFTRAK

UNIVERSITY OF MICHIGAN

IX SELLING OBE SOFTWARE TO THE INFIDELS

(AICHE Meeting - George Byrne)

ODE Circus - San Antonio - Jan 26-28, 1976

Mon. 1/26

Watts

SLA's DEPAC has

ODE	—	~ 100 uses/mo
RKF45	.	~ 25
GERK		~ 75
STIFF	(modified GEAR) (Adams coding removed)	— 150 uses/mo
STRODE	(w/loc.)	< 1

Also in use — 2 pt. BVP solvers — Scott.

Shangine working on a variable-formula RK code
(for cheap f — low overhead). This is what his ERDA grant is for.
Interest in methods for highly oscillatory problems.

Linziger

Research into ~~stability~~ stability of methods for
nonlinear stiff systems. Monotonicity assumed.
Constant-step case only so far.

Curtis

DC XIAD - old version of DIFSUB

It saves J as well as $W = (I - h\rho_0 J)^{-1}$ if space permits. (User provides work space)

CHEK - chem. kinetics + stiff solver

CHEKMAT - includes matching of conc. data by varying rate const's.

FAESIMILE - like CHEKMAT, with improved problem description language. Includes method-of-lines for 1-D.

Suggested course of actions if conv. fails:

1. Reevaluate $P = I - h\rho_0 J$ (but not J)
2. " " J and P
3. Reanalyze pivot order (which is done on basis of sparsity and num. stability).
4. Reduce h if all else fails.

Byrne

EPISODE + GEAR - ~~tests~~

Code structure diagram

Method outline

Testing philosophy

Bettis

Developed RK coeff's for various (high) orders for both 1st + 2nd order ODE's. Also for general M -fold ~~methods~~ methods where up to $y^{(M)}$ is available. Worked with Fehlberg.

Attempted to maximize abs. stab. region (part on real axis) as fn. of free parameters.

Hull

Error control thoughts. Plots cost per unit step vs. tolerance parameter. Typically there's a critical tol. above which cost does not decrease.

Proposed call seq.

Birkat

Composite LMM's -- formulation, stability, etc.
Two types:

Cyclic: take one step at a time, with LMM's chosen cyclically. Stability regions somewhat better than for BDF at orders 5, 6, 7.

Block one-step: Take k steps at once.
Get good stability to order 10. Stable at ∞ .

Returning of both codes (by Piel) hopefully will make them competitive w. GEAR:

Matrix problem solved by factoring polynomial in J , and inverting factors, in block case.

Bulirsch

Code for 2 pt BVP. Multiple shooting method.
ODE system is 1st order, with mixed endpt. cond's.

Compared 4 ODE solvers in solving this problem:

- DIFSYS (estrop)
- VOAS (Lidgwick)
- RKF7 (Toronto)
- RKF4

Found no one best choice. Each was best for some values of parameter. Tweach's prob. used for one of test prob's, with parameter = 1, ..., 18.

5
Krogh

Has written a specializer code which handles portability problem for source code written according to certain specs.

An ODE code should have property of scale invariance (under consistent changes of scale for variables).

He treats parts of system as nonstiff, part as stiff, and saves a lot. But this is done ad hoc; no automatic way.

Tue 1/27

ACH

Enright

Testing of stiff + nonstiff codes.

Data given for a nonstiff test set. EP. + GEAR as well as others, except for bad failures (costly) for EP. at $EPS = 10^{-2}$ on a single scalar problem. Also generally higher ratios of actual global errors to EPS than for ~~other~~ codes which do local extrap.

Topics in stiff methods: IRK, block methods, exp. fitting. Latter has many more disadvantages than advantage. Also: utilization of sparseness.

Byrne - ANL's role.

ANL interested in goal of syst. collection of ODE solvers.
But ANL has no manpower or money to devote to it.
Efforts to LINPACK + MINPACK preclude this.

If a sizable fund source were found (~\$5 million),
then ANL would sponsor an ODEPACK development
project to be carried out at several sites.

Hull: Hopefully, if we here agree on a calling
seq. (roughly), and if the various code
writers would be willing to ~~re~~ rewrite
front ends of existing codes to conform to that,
then we'd be a long ways toward the
desired collection.

We'd also have to agree on testing standards.

Curtis (privately): Uses pure relative error control always. Protects against zero-crossings by using weight vector update of

$$WT_n^i = |y_n^i| + .6 (WT_{n-1}^i - |y_n^i|)$$

(a convex combo. of $|y_n^i|$ and old wt.)

Reason for this: In chem. problems, iteration error on decaying components can cause instability if a floor value is used in the error control.

Save J if user's work space is large enough. Then update P with saved J as first action on convergence failure.

Klepfenstein (privately): Restriction in GEARIB on dependence of A on y is not essential. Just ask user to provide $\frac{\partial}{\partial y}(Ay)$, not A , in ADDA.

Curtis Selection of initial step size h_0 .

One choice:

$$h_0 \max_i |J_{ii}| = 1$$

Another:

$$h_0^2 \|\ddot{y}_0\| = h_0^2 \|J \dot{y}_0\| = \epsilon$$

This is a problem if $y_0^i = 0$ for any components, so that the norm calc. is ill-defined.

Call seq. descriptions by

Klopfenstein: code uses 2nd order BDF only (β_0 const.); with h kept fixed for long intervals.

ACH

Krogh

Watts

We agree on: N, T, Y .

Get hung up on error control parameters.

Wed 1/28

Highly oscillatory problems

Beitris: orbit problems with close approaches.

A type of transformation is used to eliminate singularity due to close approach.

Linear multistep methods have been derived which fit solutions of the form $e^{i\omega t}$ exactly for prescribed ω values.

The ODE would have to be analyzed to find dominant frequencies.

Implicit ODE's

Klopfenstein: $f(x, \dot{y}, y) = 0$

For a BDF method, $\Delta y = h\beta_0 \Delta \dot{y}$

Then $\frac{\partial f}{\partial \dot{y}} \Delta \dot{y} + \frac{\partial f}{\partial y} \Delta y$ becomes $(\frac{\partial f}{\partial \dot{y}} \frac{1}{h\beta_0} + \frac{\partial f}{\partial y}) \Delta y = res.$

ACA:

Krough: Wrote paper (Austin conf.) on algorithms for this.

$$f(u'', u', u, \kappa) = 0$$

$$\frac{\partial f}{\partial u''} + \sum_1^3 \frac{\partial f}{\partial z_k} \frac{\partial z_k}{\partial \kappa} = 0$$

2-pt BVP's

ACA: Method of lines on ~~PDE~~ parabolic PDE, $t \rightarrow \infty$.

Krogh: Selection of mesh is manual if done by PDE approach.

He has code for general ~~ODE~~ ODE/BVP soln. by multiple shooting. It selects break points automatically, by restricting sizes of soln. values.

Watts SLA collection of BVP codes

SUPPORT (superposition of partic. soln. and homogen. solns. - linear ODE's)

For nonlinear ODE's, use successive linearization.

Testing

Byrne : Performance profile approach of Lyness/Kozanov.

Enright + Krogh : That is not appropriate for ODE's because there the global error should be a smooth fun. of input tolerance. For quadrature this is generally not so.

SCA : Limit testing costs by presetting ~~test~~ ceilings on cost.

PARTICIPANTS 1976 ODE WORKSHOP

5/28/76

January 25 - 29
San Antonio, Texas

Dr. Dale G. Bettis
Dept. of Aerospace Engineering &
Engineering Mechanics
The University of Texas at Austin
Austin, Texas 78712
(512) 471-3912/471-7593 (office)

Prof. Thomas E. Hull
Computer Science Dept.
University of Toronto
Toronto M5S 1A1
Ontario, Canada

Prof. Theodore A. Bickart
Electrical & Computer Engineering Dept.
Link Hall
Syracuse University
Syracuse, New York 13210
(315) 423-4420 (office)
(315) 446-1857 (home)

Dr. Ralph W. Klopfenstein
RCA
David Sarnoff Research Center
Princeton, New Jersey 08540

Prof. Roland Bulirsch
Mathematisches Institut
der Technischen Universität
8 München 2, Arcisstr. 21
Postfach 202420
West Germany

Dr. Fred T. Krogh
Jet Propulsion Laboratory
MS CPB 301
4800 Oak Grove Drive
Pasadena, California 91103

Prof. George D. Byrne
Dept. of Mathematics & Statistics
University of Pittsburgh
Pittsburgh, Pennsylvania 15260
(412) 624-5857 (office)
(412) 624-5808 (home)

Dr. Werner Liniger
IBM
T.J. Watson Research Center
P.O. Box 218
Yorktown Heights, New York 10598

Dr. Alan R. Curtis
AERE Harwell
Oxfordshire
OX11 0RA
England
0235-24141 Ext. 2866 (office)

Dr. H.A. (Buddy) Watts
Applied Mathematics Div. 2642
Sandia Laboratories
Albuquerque, New Mexico 87115
(206) 264-7742 (office)

Prof. Wayne H. Enright
University of Toronto
Computer Science Dept.
Toronto M5S 1A1
Ontario, Canada
(416) 928-5474 (office)
(416) 266-1274 (home)

Dr. Alan C. Hindmarsh
Numerical Mathematics Group, L-310
Lawrence Livermore Laboratory
P.O. Box 808
Livermore, California 94550
(415) 447-1100 Ext. 3330 (office)



LAWRENCE LIVERMORE LABORATORY

Dale called 1/22 and confirmed
this letter & arrangements.

Jan 19, 1976

D. G. Bertis
ASE + EM

U. T.

Austin, TX 78712

Dear Dale,

For the record, I thought I'd better give you
some details on my travel plans for the ~~the~~ Circus.

I am arriving in San Antonio on Continental Flt. 90
at 5:21 PM on Sunday 1/25, but I do not need to
be met. A friend (who is not participant in the circus)
has asked to meet me and go out to dinner with him.
So I will see you at the Center some time that
evening (I would guess about 8:00). If there's a
discussion on an agenda going then, I'll certainly join it.

I will come prepared to present a somewhat formal
talk on the LLL family of ODE solvers, lasting about
30 min. Beyond that, I expect to be quite informal.
I'm still a little unsure of what the overall goals of
the Circus will be.

I will not be leaving San Antonio until Thursday 1/29 (Continental flt. 55, leaving 6:17 pm).

I'll probably use a taxi to get to the airport.

The reason for that timing is that Alon Curtiss had written and wanted to have some private discussions on the common features of his work and mine. I told Alon I ~~was~~ could arrange to do this on Thursday. Since I did not hear from him until after having to make my plans final, I scheduled that day free. Now I have heard from him, but still don't know if he is staying there Thursday. I suspect he is not, and in that case, I'll spend the day sightseeing on my own.

In any case, I do need to have my room at the Center for Wed. night. Is that OK?

I believe George Byrne has told you that he and I will room together.

I'm looking forward to the meeting.

Regards,

Alan Hindmarsh



THE TEXAS INSTITUTE *for* COMPUTATIONAL MECHANICS
THE UNIVERSITY OF TEXAS AT AUSTIN, 78712

Telephone: (512) 471-1391

January 15, 1976

Dr. Alan C. Hindmarsh
Lawrence Livermore Laboratory
P.O. Box 808
Livermore, California 95550

Dear Dr. Hindmarsh:

To date, there has been only one change regarding the ODE Circus in San Antonio Jan. 26-28. Dr. Herman A. Watts of Sandia Laboratories will be attending in place of L.F. Shampine.

Upon your arrival in San Antonio, should you need a ride from the airport, or any other assistance, please contact us by calling the Lutcher Center at 828-2842 (512). You may be contacted at this same number throughout the meeting.

For those of you arriving Sunday evening, Jan. 25, a light meal will be available at the Lutcher Center. No activities have been scheduled for Sunday, although it is hoped that, at this time, we can reach a consensus on an agenda for the following days. Monday will be devoted to hearing from all participants who wish to speak at that time.

Breakfast will be served daily at the Lutcher home from 7:00 to 8:30 a.m. Tentatively, we have planned to dine out in San Antonio Monday evening and Tuesday afternoon. All other meals will be available at the center.

If there are last minute changes in your plans, or if I can be of assistance, please contact me or Pam Rossano at the University of Texas at 471-3912 or 471-7593 before Sunday, or at the Lutcher Center Sunday through Thursday morning. I am looking forward to our meeting in San Antonio.

Sincerely,

Dale Bettis

pr



THE TEXAS INSTITUTE *for* COMPUTATIONAL MECHANICS
THE UNIVERSITY OF TEXAS AT AUSTIN, 78712

Telephone: (512) 471-1391

Telephone: (512) 471-1391 , (512) 471-7593

TO: ODE Circus Participants
FROM: Dale Bettis *Dale Bettis*
DATE: 20 NOV 1975

As of now, the following have made definite plans to attend the San Antonio meeting: Dale G. Bettis, Theodore A. Bickart, Roland Bulirsch, George D. Byrne, Alan Curtis, Wayne H. Enright, Alan C. Hindmarsh, Thomas E. Hull, Ralph W. Klopfenstein, Fred T. Krogh, Werner Liniger, and ~~L.F. Shampine~~ *B. Watts*. Joan Walsh and Robert K. Brayton, who is on sabbatical at Imperial College in London, will be unable to attend. Also, C.W. Gear will not be able to come to San Antonio, but he will participate in any future meetings and has offered to be a host of a subsequent meeting if necessary.

For those participants who were not at the "ODE Software Workshop" held at Argonne during June 1974, notes from that meeting are enclosed for your information.

Housekeeping:

1) Chalk board facilities are available, but limited. An overhead projector will be available. Please let us know if you have any requests with respect to visual aids.

2) The Lutcher Center is located in an isolated residential area of San Antonio, and is accessible only by taxi or car. If you are arriving by plane on Sunday, 25 JAN 1976, and want to be met, please let me know when and what flight and we will try to meet you; if we can't, you will be informed. Enclosed is a map showing the Lutcher Center and the airport.

3) The accomodations include two rooms for one occupant, five rooms for two occupants (separate beds and waiting room), and the old master bedroom. All rooms have private baths and sitting rooms. If you have a special request regarding the rooms, please let us know. The room rates are \$10 per bed per night.

4) The cost for meals at the Lutcher Center will be: breakfast - \$3.50, lunch - \$5.00, dinner - \$10.50. We will plan to dine out in San Antonio on two of the three evenings and perhaps for one lunch. If there are any meals you do not wish to take at the Lutcher Center, please let us know in advance so that we can schedule accordingly. In addition, coffee and rolls will be served throughout the day.

Pam Rossano, my secretary, will be the person in charge of "housekeeping", so please help her in this endeavor by providing us with any information you think pertinent.

I look forward to our visit in San Antonio and to some interesting discussions. In the meantime, if you have any suggestions, please let us know.

DGB/pr
Enclosures



12/4/75

Dale Bettis)

Here are some copies of handouts that were used for the 1974 ANL ODE Workshop.

The first page is a list of topics George B. and I made up, and the second is a list of discussion questions by Wayne Cowell (who hosted the meeting). These were mailed to participants before the meeting, and I suggest something similar to that be done for this one.

Finally, here's a copy of the "program" that was (more or less) actually followed.

I hope these are useful.

Alan Hindman



LAWRENCE LIVERMORE LABORATORY

October 20, 1975

Dr. Dale G. Bettis
Dept. of Aerospace Eng. and
Engineering Mechanics
University of Texas at Austin
Austin, TX 78712

Dear Dr. Bettis:

I am delighted to accept your invitation to the San Antonio ODE workshop. As you know, I was at the similar workshop at Argonne last year, and I am very much interested in the subject of ODE software.

I talked to George Byrne on the phone today, and learned that you will be meeting with him at Argonne next week. In view of that, I don't think I need to provide any suggestions at this time. George has quite a bit of material from the 1974 workshop that will help. My only advice at this point would be to give to those participants who were not at the 1974 workshop a copy of some notes that were put together from it. This will help avoid some repetition for the others.

Please let me know if I can assist you in any way on this meeting.

For the record, I would prefer that you use my laboratory address for correspondence:

Numerical Mathematics Group, L-310
Lawrence Livermore Laboratory
P.O. Box 808
Livermore, CA 94550
Phone (415) 447-1100, Ext. 3330

Very sincerely,

A.C. Hindmarsh

ACH/jat

12/12/75

Fred / Dave —

Attached is a copy of an invitation I received yesterday, to a workshop on numerical solution of ODE's in San Antonio next January. I had heard of this informally in conversation in Boston last month. The workshop is intended to carry on the effort begun at the ODE Workshop at Argonne in June 1974, at which I was a one of five "core leaders".

In contrast to the ANL workshop, there is no funding provided for participants in this one.

The letter from Bettis asks for an early reply. I have already relayed privately that I am very much interested in this activity and will come if possible. With your permission I would like to send a positive reply as soon as possible.

Alan Hindmarsh



THE TEXAS INSTITUTE *for* COMPUTATIONAL MECHANICS
THE UNIVERSITY OF TEXAS AT AUSTIN, 78712

Telephone: (512) 471-1391

October 10, 1975

Dr. Alan C. Hindmarsh
1330 Hillcrest Ave.
Livermore, California 94550

Dear Dr. Hindmarsh:

Mem - N 2nd
A workshop devoted to the numerical solution of ordinary differential equations will be held at the Lutcher Center in San Antonio, Texas on January 26, 27, and 28, 1976. It is hoped that you will be able to participate in this workshop. Enclosed is a basic description of the workshop and a list of the invited participants.

San Antonio is a most pleasant place to be during the winter months, and the spacious grounds of the Lutcher home will provide a convivial atmosphere for our meeting.

Since accommodations at the Lutcher Center are limited, I would appreciate your response concerning your attendance at this meeting at your earliest convenience. About half of the invited participants have made plans to attend the meeting, and everyone is looking forward to some good discussions.

I would appreciate any suggestions you might have concerning the upcoming meeting. If I can provide you with further information or assist you in any way, please feel free to contact me at:

Department of Aerospace Engineering and Engineering Mechanics
The University of Texas at Austin
Austin, Texas 78712

Telephone: (512) 471-7593

Once again, I hope that you will be able to attend the workshop in January.

Sincerely yours,

Dale G. Bettis

Dale G. Bettis

pr
Enclosure

Ordinary Differential Equation Circus

Recently, there have been many significant advances in the development of both methods and codes for solving ordinary differential equations; and in the past few years there have been several symposiums, and sessions at larger conferences devoted to the subject of methods and techniques for solving ODE's. There is currently a need for a meeting of a small group of experts who have as their primary interest the numerical solution of ODE's. The main purpose of the meeting would be the exchange of current developments of methods and, if applicable, the coordination of the development of codes. It is proposed that the first meeting be held the 26th through the 28th of January, 1976, in San Antonio, Texas.

It is the consensus of several of us that the subject matter be limited to the initial value problem for ODE's, including stiff and non-stiff systems. In order to have a homogeneous group who have similar interests, several of us have agreed upon a preliminary list of participants for the meeting. The meetings will be informal. The participants will be free to speak about any aspect of their work. Papers will not be required, nor will a proceedings be published.

This meeting may become the first of a sequence. Assuming that there is a need for additional meetings every year or so, Fred Krogh has agreed to become the host for a second meeting, and Larry Shampine for a third. If the meetings evolve to permanence, it is expected that each participant will ultimately become a host. The responsibilities of the host will be limited to providing both a meeting room, and information about accommodations, etc. Basically, we hope that the host will have a minimum of administrative work.

At present, there is no funding available for the meeting or for travel. Hopefully, there will be funds for subsequent meetings.

In order to coordinate with other groups who have interest in our activities, observers from at least two groups will be invited (Applied Mathematics Division, Argonne National Laboratory ^(SDB) and the Office of Computing Activities, The National Science Foundation). (?)

For the first meeting in San Antonio, the sessions and accommodations will be at the Lutchter Center, an old home owned by the University of Texas. Accommodations and meals will cost approximately \$30 a day. Lodging at the Lutchter Center will be available from Sunday afternoon, the 25th through the morning of the 29th. (The 82nd Annual Meeting of the Mathematical Association of America and the American Mathematical Society will be held in San Antonio January 22-26, 1976.)

(Th. Mon. !)

Preliminary Proposed List for

ODE Workshop Participants (15, of whom 7 were at ANL Workshop)

Prof. Dale G. Bettis
Dept. of Aerospace Engineering
University of Texas
Austin, Texas 78712

Prof. Theodore A. Bickart
Electrical & Computer Engineering Dept.
Link Hall
Syracuse University
Syracuse, New York 13210

Dr. Robert K. Brayton
IBM, T.J. Watson Research Center
P. O. Box 218
Yorktown Heights, New York 10598

Prof. Roland Bulirsch
Mathematisches Institut
der Technischen Universität
8 München 2, Arcisstr. 21
Postfach 202420
West Germany

Prof. George D. Byrne *as ANL rep.*
University of Pittsburgh
Pittsburgh, PA 15213

Dr. Alan Curtis
AERE Harwell
Computer Science and Systems Div.
Didcot, Berkshire OX 11 0RA
ENGLAND

Prof. Wayne H. Enright
University of Toronto
Computer Science Dpt.
Toronto, Ontario CANADA

Dr. Joan Walsh
University of Manchester
Department of Mathematics
M13 9PL
ENGLAND

Prof. C.W. Gear
Dept. of Computer Science
University of Illinois
Urbana, Illinois 61801

Dr. Alan C. Hindmarsh
1530 Hillcrest Ave.
Livermore, California 94550

Prof. Thomas E. Hull
Computer Science Department
University of Toronto
Toronto 5, Ontario CANADA

Dr. Ralph W. Klopfenstein
RCA
David Sarnoff Research Center
Princeton, N.J. 08540

Dr. Fred T. Krogh
Jet Propulsion Laboratory
MS CPR 301
4800 Oak Grove Drive
Pasadena, California 91103

Prof. Bengt Lindberg
Computer Science Department
University of Toronto
Toronto 5, Ontario
CANADA

Dr. L. F. Shampine
Applied Mathematics, Div. 1722
Sandia Laboratories
Albuquerque, New Mexico 87115