APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY (ACES)

NEWSLETTER

Vol. 16 No. 1 March 2001

TABLE OF CONTENTS

ACES NEWSLETTER STAFF

EDITOR-IN-CHIEF, NEWSLETTER
Bruce Archambeault
IBM
3039 Cornwallis Road
B306 Dept 18 DA
Research Triangle Park, NC 27709
Phone: 9190486-0120
email:barch@us.ibm.com

ASSOCIATE EDITOR-IN-CHIEF
Ray Perez
Martin Marietta Astronautics
MS 58700, PO Box 179
Denver, CO 80201, U.S.A
Phone: 303-977-5845
Fax: 303-971-4306
email:ray.j.perez@lmco.com

EDITOR-IN-CHIEF, PUBLICATIONS
Andrew Peterson
Georgia Institute of Technology, ECE
777 Atlantic Drive
Atlanta, GA 30332-0250
Phone: 404-894-4697
Fax: 404-904-5935
email:peterson@ee.gatech.edu

MANAGING EDITOR
Richard W. Adler
Pat Adler, Production Assistant
Naval Postgraduate School/ECE Department
Code ECAB, 833 Dyer Road, Room 437
Monterey, CA 93943-5121, U.S.A.
Phone: 831-646-1111
Fax: 831-649-0300
email:rwa@attglobal.net

EDITORS

CEM NEWS FROM EUROPE
Pat R. Foster
Microwaves and Antenna Systems
16 Peachfield Road
Great Malvern, Worc, UK WR14 4AP
Phone: +44 1684 5744057
Fax: +44 1684 573509
email:prf@maasas1.demon.co.uk

MODELER'S NOTES
Gerald Burke
Lawrence Livermore National Labs.
Box 5504/L-156
Livermore, CA 94550, U.S.A.
Phone: (510) 422-8414
Fax: (510) 422-3013
email:burke2@llnl.gov

TECHNICAL FEATURE ARTICLE
Andy Drozd
ANDRO Consulting Services
PO Box 543
Rome, NY 13442-0543 U.S.A.
phone: (315) 337-4396
Fax: (314) 337-4396
email:andro1@aol.com

PERSPECTIVES IN CEM
Manos M. Tentzeris
Georgia Institute of Technology
ECE Dept.
Atlanta, GA 30332-0250
Phone: (404) 385-0378
email:eentze@ece.gatech.edu

THE PRACTICAL CEMIST
W. Perry Wheless, Jr.
University of Alabama
P.O. Box 11134
Tuscaloosa, AL 35486-3008, U.S.A.
Phone: (205) 348-1757
Fax: (205) 348-6959
email:wwheless@ua1vm.ua.edu

TUTORIAL
Bruce Archambeault
IBM
Dept. 18DA, Bldg. 306
PO Box 12195, 3039 Cornwallis Road
Research Triangle Park, NC 27709
Phone: (919) 486-0120
Fax: (919) 543-8324
email:barch@us.ibm.com

ACES JOURNAL

EDITOR-IN-CHIEF
Ahmed Kishk
EE Department
University of Mississippi
University, MS 38677 U.S.A.
Phone: (662) 232-5385
Fax: (662) 232-7231
email:ahmed@olemiss.edu

ASSOCIATE EDITOR-IN-CHIEF
Allen Glisson
EE Department
University of Mississippi
University, MS 38677 U.S.A.
Phone: (662) 232-5353
Phone: (662) 232-7231
email:aglisson@olemiss.edu

NEWSLETTER ARTICLES AND VOLUNTEERS WELCOME

The ACES Newsletter is always looking for articles, letters, and short communications of interest to ACES members. All individuals are encouraged to write, suggest, or solicit articles either on a one-time or continuing basis. Please contact a Newsletter Editor.

AUTHORSHIP AND BERNE COPYRIGHT CONVENTION

The opinions, statements and facts contained in this Newsletter are solely the opinions of the authors and/or sources identified with each article. Articles with no author can be attributed to the editors or to the committee head in the case of committee reports. The United States recently became part of the Berne Copyright Convention. Under the Berne Convention, the copyright for an article in this newsletter is legally held by the author(s) of the article since no explicit copyright notice appears in the newsletter.

OFFICER'S REPORTS

President's Post

Perry Wheless, ACES President

This message for the *ACES Newsletter* was prepared on January 17, a noteworthy date because the email this morning contains enough favorable votes for me to announce that the ACES Board of Directors has approved some significant election changes. Dick and Pat Adler will prepare and send special notification of these changes to the membership as soon as possible. If you are a member of ACES, you should have already seen their notification before you are reading this *Newsletter*. The redundant mention here is because we want all members to take note of these changes.

ACES has nine Directors, elected by the membership to staggered three-year terms. Three Director positions are decided by election each year, so that the full Board turns over every nine years. A list of all the current Directors and their term expiration years appears in each *Newsletter*. The Directors meet annually at the ACES conference to conduct the Society's business. A second major meeting of the Directors occurs each year in the Fall, usually in October, by teleconference. Between major meetings, the Directors occasionally act on business items by electronic information exchange, such as this most recent vote on election details.

The most significant election change is that nominations will now close on May 1 annually. Candidate statements will appear in the July *ACES Newsletter* in the future, and the election procedure will be concluded in time to report the results in the November *Newsletter*. Please direct nominations directly to Adalbert Konrad, Elections Committee Chair, at konrad@power.ele.utoronto.ca. You should contact your potential candidate(s) to verify that (1) their dues are currently paid, so that they are officially members of the Society, (2) they will serve if elected, (3) they will be expending time and effort to advocate for, and advance, ACES, and (4) they are both willing and able to attend the annual Board of Directors business meetings held at the conference in Monterey. Please advise them that a written candidate's statement will be required of them no later than May 25.

In addition to allowing us to archive candidate statements in the *Newsletter* for convenient future reference, and to report election results in advance of the annual conference business meeting, this will allow incoming new Directors to participate in the Fall meeting as "observers," so they will be aware of current ACES business issues before they are installed in office at the next Annual Meeting of Members at conference. The usual schedule at conference is to have the Board meeting on the day prior to the Meeting of Members, so old/outgoing Directors vote at that business meeting and then the new Directors are installed to start their three-year term the next day. With the revised election schedule, new Directors will thus have the opportunity to observe two meetings before their term begins. We believe the new election schedule will allow new Directors to become better informed and have time for reflection and planning in advance of their terms. It is anticipated that a more informed and involved Board of Directors will positively impact the health and vitality of ACES into the future.

Please note that Bruce Archambeault is our new *Newsletter* Editor-in-Chief, starting with this issue. If you wish to contribute to, or discuss, the Newsletter, you can reach Bruce electronically at barch@us.ibm.com. Ray Perez has agreed to continue his association with the *Newsletter* as Associate Editor-in-Chief. We are indebted to Ray for his long and outstanding service as *Newsletter* Editor-in-Chief. We have all been beneficiaries of his contributions, and I would like to take this opportunity to publicly thank Ray on behalf of good ACESians everywhere.

If you have not yet completed your March conference registration and travel plans, it is time to move those chores up on your priority list. See you in Monterey!!

Perry Wheless
ECE Department, University of Alabama
Box 870286
Tuscaloosa, AL USA 35487-0286

THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY, INC.

NOTICE OF THE ANNUAL BUSINESS MEETING

Notice is hereby given that the annual business meeting of the Applied Computational Electromagnetics Society, Inc. will be held on Tuesday 20 March 2001, in 102 Glasgow Hall at the Naval Postgraduate School, Monterey, CA. The meeting is scheduled to begin at 7:45 AM PST for purposes of:

1. Receiving the Financial Statement and Treasurer's Report for the time period ending 31 December 2000.
2. Announcement of the Ballot Election of the Board of Directors.

By order of the Board of Directors
Bruce Archambeault, Secretary

ANNUAL REPORT 2000

As required in the Bylaws of the Applied Computational Electromagnetics Society, Inc. a California Nonprofit Public Benefit Corporation, this report is provided to the members. Additional information will be presented at the Annual Meeting and that same information will be included in the July Newsletter for the benefit of members who could not attend the Annual Meeting.

MEMBERSHIP REPORT

As of 31 December 2000, the paid-up membership totaled 314, with approximately 30 % of those from non-U.S. countries. There were 21 full time students, Unemployed and Retired; 66 industrial (organizational); and 227 individual members. The total membership has decreased by 17 % since 1 Jan 2000, with non-U.S. membership increasing by 40%.

Bruce Archambeault, Secretary

MEMBERSHIP RATES

FULL-TIME STUDENT/RETIRED/UNEMPLOYED RATE IS $25 FOR ALL COUNTRIES

AREA	INDIVIDUAL SURFACE	INDIVIDUAL AIRMAIL	ORGANIZATIONAL (AIRMAIL ONLY)
US & CANADA	$65	$65	$115
MEXICO, CENTRAL & SOUTH AMERICA	$68	$70	$115
EUROPE FORMER USSR TURKEY SCANDINAVIA	$68	$78	$115
ASIA, AFRICA MID EAST, PAC RIM	$68	$85	$115

REVISED 1999 FINANCIAL REPORT

ASSETS

BANK ACCOUNTS	1 JAN 1999	31 DEC 1999
MAIN CHECKING	2,705	13,631
EDITOR CHECKING	2,089	3,498
SECRETARY CHECKING	2,440	2,329
SAVINGS	108	109
HIGH RATE SAVINGS	43,911	66,227
CREDIT CARD	27,003	11,357
CD #1	11,627	12,259
CD #2	11,591	12,192
CD #3	11,627	12,147
CD #4	11,625	12,230
TOTAL ASSETS	$124,726	$145,979

LIABILITIES: $0

NET WORTH 31 December 1999: $145,979

INCOME

Conference	40,412
Short Courses	18,861
Publications	1,340
Membership	33,302
Interest & misc.	6,765
TOTAL	$100,680

EXPENSE

Conference	33,836
Short Courses	10,404
Publications	9,047
Services (Legal, Taxes)	4,132
Postage	5,877
Supplies & misc.	16,134
TOTAL	$79,430
NET INCREASE FOR 1999	$21,250

In 1998 the net increase was $7,523. In 1999 we enjoyed a net gain of $21,250. Our current net worth, $145,979 has increased by 17% from last year.

Allen Glisson
Treasurer

2000 FINANCIAL REPORT

ASSETS

BANK ACCOUNTS	**1 JAN 2000**	**31 DEC 2000**
MAIN CHECKING	13,631	37,085
EDITOR CHECKING	3,498	3,289
SECRETARY CHECKING	2,329	3,195
SAVINGS	109	109
HIGH RATE SAVINGS	66,227	45,820
CREDIT CARD	11,357	7,775
CD #1	12,259	12,933
CD #2	12,192	12,859
CD #3	12,147	12,682
CD #4	12,230	12,825
TOTAL ASSETS	$145,979	$148,572

LIABILITIES: $0

NET WORTH 31 December 2000: $148,572

INCOME

Conference	52,047
Short Courses	16,410
Publications	517
Membership	23,729
Interest & misc.	7,409
TOTAL	$100,112

EXPENSE

Conference	44,510
Short Courses	8,197
Publications	13,574
Services (Legal, Taxes)	5,416
Postage	6,721
Supplies & misc.	5,304
Website	13,797
TOTAL	$97,519
NET INCREASE FOR 2000	$2,592

In 1999 the net increase was $21,250. In 2000 our net gain was $2,592. Our current net worth, $148,572 has increased by 2% from last year.

Allen Glisson
Treasurer

PERMANENT STANDING COMMITTEES OF ACES INC.

COMMITTEE	CHAIRMAN	ADDRESS
NOMINATIONS	Adalbert Konrad	University of Toronto ECE Department 10 King's College Road Toronto, ON, CANADA M5S 1A4
ELECTIONS	Pingjuan Werner	Penn State University 321 Oakley Drive State College, PA 16803
FINANCE	Melinda Piket-May	University of Colorado/Boulder Engineer Circle Boulder, CO 80309-0425
PUBLICATIONS	Andrew Peterson	Georgia Institute of Technology School of ECE Atlanta, GA 30332-0250
CONFERENCE	Doug Werner	Penn State University 211A EE East University Park, PA 16802
AWARDS	Pat Foster	MAAS 16 Peachfield Road Great Malvern, UK WR14 4AP

MEMBERSHIP ACTIVITY COMMITTEES OF ACES INC.

COMMITTEE	CHAIRMAN	ADDRESS
SOFTWARE VALIDATION	Bruce Archambeault	IBM 158 Lin Tilley Road Durham, NC 27712
HISTORICAL	Robert Bevensee	BOMA Enterprises PO Box 812 Alamo, CA 94507-0812

COMMITTEE REPORTS

CONFERENCE COMMITTEE

The ACES 2001 technical planning committee has been hard at work over the past year to plan an exciting and pleasant conference in the best tradition of ACES. In addition to excellent plenary speakers, we have a very strong technical program arranged that includes papers contributed from colleagues around the world. Over one hundred papers have been submitted for the program. I would like to personally thank the session organizers for all their hard work in putting their sessions together. A listing of our session organizers is on the ACES website (http://aces.ee.olemiss.edu) and includes US and international colleagues. We have put together seventeen sessions that will be offered over three days (March 20, 21, and 22) and will again offer in conjunction with the interactive poster session and vendor exhibits, a wine and cheese tasting party. In addition, we are offering ten short courses/workshops to be given on March 19th and March 23rd. The full-listing of short courses, instructors, and abstracts are on the ACES website. We used the results from the ACES on-line short course survey, conducted over the course of last summer, in developing these offerings.

I would like to take this opportunity to thank the people who make this conference possible. Special gratitude is extended to Richard and Pat Adler for all of their hard work and support of the conference. I would also like to personally thank the ACES 2001 Conference Technical Committee for all their hard work and dedication throughout the year. In particular, I wish to thank: co-chairs Doug Werner and Ed Rothwell, vendor chair Tim Holzheimer, short course chair John Shaeffer, and publicity chair Keith Lysiak. All have done an outstanding job for the society.

I would especially like to thank and commend Prof. Atef Elsherbeni, as our electronic publication chair, for his hard work throughout the year in making the ACES on-line submission system the premier method for electronic paper submission. Atef has worked closely with myself and others throughout the year making fully electronic submission possible. His hard work will payoff for many years to come (I predict that future ACES Technical Chairs will be very appreciative to have the system set-up this year by Atef and his students). We are now in a position to accept papers (and revisions as necessary), review the papers, and provide the papers in electronic form for reduction to both paper and CDROM distributed proceedings. Atef has served the society this year (as in past years) above and beyond the call of duty.

In summary, the ACES 2001 Team has been hard at work for the society in putting together an excellent technical program. We hope that this year's conference will provide a unique opportunity for all of you to come together from around the world to share your knowledge in computational electromagnetics, see old acquaintances and to make new friends. As a leader of our field once commented to me (paraphrased), "The ACES meeting is the first meeting of the year and hence represents a unique opportunity to see what our colleagues have been accomplishing since the summer meetings." So please plan on attending and contributing to the conference and to ACES.

Best wishes to all of you,

Leo C. Kempel
Technical Program Chair
ACES 2001 Conference

PUBLICATIONS COMMITTEE

I am pleased to announce that Bruce Archambeault has agreed to serve ACES in a new capacity, as Editor of the ACES Newsletter. Bruce is currently a member of the Board of Directors and has been serving as Secretrary of the Board this past year. I'm certain that he would appreciate any suggestions as to new directions that our Newsletter should take and even more certain he would welcome volunteers in order to help carry out both old and new initiatives.

I would like to thank Ray Perez for his dedicated service as Newsletter Editor for the 6 year period 1994-2000!. Ray also recently co-edited the special issue of the ACES Journal on CEM Techniques in Mobile Wireless Communications (November 2000).

ACES Journal Special Issues planned for the near future include an issue on Computational Bioelectromagnetics (guest edited by Cynthia Furse, Susan Hagness, and Ulrich Jakobus), tentatively scheduled for July 2001. For 2002, we are planning special issues on High Resolution Methods (guest editors: Malcolm Bibby and Andrew Peterson) and Adaptive Methods (guest editor: Jin-Fa Lee). Announcements for these may be found in this issue of the Newsletter or on the ACES web page (http://aces.ee.olemiss.edu).

Please send suggestions for other special issue topics. If you are interested in guest editing an issue, plan on about an 18 month lead time to allow adequate advertising, paper review, and final processing. Now is the time to start planning for the 2003 issues--Let's hear from you!

Atef Elsherbeni deserves the gratitude of all ACESians for coordinating a considerable effort during the past few years toward the development of software enabling the ACES Journal to accept and process papers electronically. Please read the article by Elsherbeni and Inman in the November 2000 Newsletter for details, and plan to make use of the online submission process!

Andrew F. Peterson
School of Electrical & Computer Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0250
USA

(404) 894-4697 (office)
(404) 894-5935 (shared FAX)
peterson@ee.gatech.edu

JOINT NOMINATIONS and ELECTIONS COMMITTEE REPORT

Adalbert Konrad, Nominations Chair, konrad@power.ele.utoronto.ca
Ping Werner, Elections Chair, plw7@psu.edu

ACES has nine directors, elected by the membership to a three-year term of office. The terms are staggered, with three expiring each year. Three new Directors are elected annually, and installed in office at the annual ACES conference in Monterey.

On 17 January 2001, the ACES Board of Directors voted to approved proposed changes in our annual election process. This report will serve as the required notification to the membership of these changes. A list of the changes, which was made effective immediately by the majority vote of the Board of Directors, follows:

1. The annual closing date for nominations will be May 1.
2. Candidate statements must be submitted by May 25 to ensure inclusion in the July Newsletter.
3. Ballots will be mailed in July. **Ballots will refer to the ACES Newsletter** for candidate statements. Candidate statements will appear in the July ACES Newsletter, regardless of whether the Newsletter is distributed in hardcopy or electronically in the future.
4. The deadline for the return of ballots will be August 31.
5. The votes will be counted by September 15, and announcements of the winners will appear in the next issue (nominally November) of the ACES Newsletter.
6. The three newly elected Directors will be installed in office at the next Annual Meeting of Members, which occurs at the annual conference.

Among other benefits, these changes will allow incoming new Directors to participate in the Fall Board of Directors meeting, which has been occurring recently in October by telephone conference call. Although they will not be voting members at that time, their participation should be informative and useful to them when they actively begin their three-year term.

DIRECTORS-AT-LARGE

Bruce Archambeault	2001	Allen W. Glisson	2002	Masanori Koshiba	2003
Anthony Brown	2001	Guiseppe Pelosi	2002	Osama Mohammed	2003
Eric Michielssen	2001	Perry Wheless, Jr.	2002	Tapan Sarkar	2003

Adalbert Konrad
Nominations Chair

NOMINATIONS COMMITTEE CANDIDATES FOR 2001 ACES BoD ELECTION

GENERAL BACKGROUND

BRUCE ARCHAMBEAULT received his B.S.E.E degree from the University of New Hampshire in 1977 and his M.S.E.E degree from Northeastern University in 1981. He received his Ph.D. from the University of New Hampshire in 1997. His doctoral research was in the area of computational electromagnetics applied to real-world EMC problems. In 1981 he joined Digital Equipment Corporation and through 1994 he had assignments ranging from EMC/TEMPEST product design and testing to developing computational electromagnetic EMC-related software tools. In 1994 he joined SETH Corporation where he continued to develop computational electromagnetic EMC-related software tools and used them as a consulting engineer in a variety of different industries. In 1997 joined IBM in Raleigh, N.C. where he is the lead EMC engineer, responsible for EMC tool development and use on a variety of products. During his career in the U.S. Air Force he was responsible for in-house communications security and TEMPEST/EMC related research and development projects.

The candidate has authored or co-authored a number of papers in computational electromagnetics, mostly applied to real-world EMC applications. He is currently an Associate Editor for the IEEE Transactions on Electromagnetic Compatibility. He is also the lead author of the book entitled *EMI/EMC Computational Modeling Handbook*.

PAST SERVICE TO ACES

The candidate has been serving as a member of the ACES Board of Directors since 1998 and is the current secretary to the Board of Directors. He is heavily involved in the new joint ACES/IEEE EMC Society web page focused on modeling, validation and standard problems. He has served as the Tutorial Editor for the ACES Newsletter, and has recently been named as Editor-in-Chief of the ACES Newsletter.

The candidate has attended most of the ACES Annual Reviews since 1987, and has presented a number of papers through the years.

CANDIDATE'S PLATFORM

Over my career, I have seen a tremendous increase in the speed of digital electronics, and a resulting increase in both EMC regulations and EMC problems. These increases have caused a real need for software tools to help the practicing EMC engineer. Rules-of-thumb and closed-form equations seldom provide the necessary accuracy for these practical problems. ACES has grown from its initial Method of Moments and military applications concentration to encompass all numerical techniques and a variety of commercial as well as military applications. I believe ACES provides a vital link between the E/M code developers and the user community. I will work to strengthen this linkage between developers and users, and ensure the applications considered are real-world applications.

Applying numerical methods to real-world applications is seldom a trivial task. Identifying the correct source and other model parameters is vital to an accurate result. Towards this end, I feel it is extremely important that ACES be a leader in the education of computational electromagnetic techniques as they apply to real-world problems. Engineers need to understand when it is appropriate to use which computational technique, and when a different technique would provide better or faster results. Thus I will promote activities to help educate practicing engineers in numerical methods from a real-world point of view.

Another critical part of using computational tools is to properly validate the results from the modeling tool. All too often, measurements are assumed to be the only way to validate models, even when the measurement is often full of uncertainty itself. I have been very active to use other methods (in addition to measurements) for model validation. I would plan to continue to push for model validation standards and to educate the user community about various validation techniques and standard modeling problems.

OTHER UNIQUE QUALIFICATIONS

I have found that it is rare for an individual to possess an understanding of theoretical electromagnetics, computational techniques, and a practical, day-to-day understanding of the real world of test, measurement and design. I feel that my understanding of all three of these areas make me a strong potential resource to add to the other skills already within ACES.

GENERAL BACKGROUND

ANDRZEJ KRAWCZYK has earned three degrees in electrical engineering. He received M.S. and Ph.D. degrees from the Technical University of Lodz, Poland in 1971 and 1977, respectively and a Doctor Habilitate from the Institute of Electrical Engineering, Warsaw, Poland in 1988. His first two thesis topics involved electromagnetic field in electrical machines while the last one was connected with the mathematical and numerical modeling of electromagnetic field. In 1971 he joined the Institute of Electrical Engineering, Transformer Branch in Lodz, where he began developing methods of computational electromagnetics to compute electromagnetic field in transformers. He contributed the iterative approach to the method of integral equation. In 1973 he began the Ph.D. course at the Technical University of Lodz which he finished defending his Ph.D. in 1977. After his doctorate he rejoined the Institute of Electrical Engineering again, but this time he was in the Department of Fundamental Research in Warsaw. In 1981 he stayed for 6 months at the Okayama University, Japan. After that he began investigating the boundary element method (BEM) which led to the completion of his habilitation thesis in 1988; the topic of the thesis was the application of the boundary element method to the simulation of transient problems. He was also the co-author of the BEM package. In 1985 he joined Southampton University for three months where he collaborated with Prof. Percy Hammond on energetic and geometric properties of electromagnetic fields. In 1991 he visited Kanazawa University in Japan where he was investigating the problems of magnetomechanics.

Dr. Krawczyk has authored or co-authored about 90 papers on computational electromagnetics. Recently, since 1995 his papers are mainly connected with the computation of bioelectromagnetic structures. Some of them were published in the IEEE Transactions on Magnetics, COMPEL and post-conference books and special issues of journals. He co-authored (with John A. Tegopoulos, Technical University of Athens) a book entitled *Numerical Modelling of Eddy Currents* published by Oxford University Press in 1993. He also authored several book chapters and edited and co-edited a few special post-conference issues of COMPEL and Journal of Technical Physics. In 1985 he began co-organizing ISEF conferences and since 1991, the Polish-Japanese Joint Seminars. Andrzej Krawczyk is a reviewer for many international journals and conferences. In 1999 he obtained the title of professor which is given by the President of Poland. At present he has the position of professor at the Institute of Electrical Engineering in Warsaw and at the Technical University of Czestochowa. Since 1997 he is the President of the Polish Society of Applied Electromagnetism (elected for second three-year term in 2000). He is also a member of IEEE, ACES and the International Compumag Society.

PAST SERVICE TO ACES

The candidate's past service to ACES includes reviewing papers for the ACES Journal.

CANDIDATE'S PLATFORM

The last decades have brought a tremendous increase of the theory and practice of computational electromagnetics. Now, at the turn of century, the methods of computational electromagnetics are approaching perfection, as to the theory and are being sold in commercial packages. Thus, now one looks for practical use of them. Because ACES has played an important role in achieving this high level of the methods, ACES again is expected to play the same role in achieving high level of their practical usage. The area of practical problems is very wide but I would see ACES to help in developing rather new areas of applications, like computation of bioelectromagnetic structures and EMC problems.

In electromagnetic community we have already a few international societies, either formal like International Compumag Society or informal, like those connected with ISEM, ISEF and other conferences. To remain distinguished from existing ones, ACES should, in my opinion, pay attention to the following direction: to develop deep links between all the sciences dealing with applied electromagnetics, like electrical engineering, applied mechanics, applied physics, plasma engineering, biology, material engineering and, last but not least, medicine.

OTHER UNIQUE QUALIFICATIONS

Coming from a Middle European country, I am in a unique position to promote ACES activity among people from these countries. Also I am strongly connected with other electromagnetic communities and conferences (ICS, ISEF, ISEM) as well as with Japanese experts affiliated with the Japan Society of Applied Electromagnetics and Mechanics which may help in organizing joint activities and reciprocal relationships.

GENERAL BACKGROUND

RAY PEREZ was born in 1958 and moved to the United States at the age of fourteen. He graduated with a B.S. degree in Physics in 1979 and a M.S. degree in High Energy Particle Physics in 1981, both from the University of Florida, Gainesville, Florida. Later, while looking for a more "practical" side of electromagnetic and electronics work, he quit his doctoral studies in physics and changed his profession to electrical engineering. He received his M.S. and Ph.D. degrees in electrical engineering in 1983 and 1988, respectively.

Since 1988 Ray has been working at the Jet Propulsion Laboratory of the California Institute of Technology, Pasadena, CA. Over the last six years he has been relocated by his company to work with Lockheed Martin Corporation in Denver, Colorado and Ball Aerospace on several projects. Ray's early work in computational electromagnetics (CEM) dealt with minimizing electromagnetic interference (EMI) in spacecraft electronics, especially for interplanetary spacecraft which are exposed to very adverse space radiation environments. Over the last few years Ray has been involved more with electronic design (RF/MW and analog/digital) for Telecommunication systems. He uses CEM to "fine tune" various designs. Ray's present business is in the area of wireless and telecommunication systems design for satellites, mobile wireless systems, and wireless networking. He is one of the lead designers of the telecommunication system of the Mars Global Surveyor (1996), Stardust (1998), Mars Surveyors Orbiter and Lander (1998—this one "crashed" on Mars), Genesis (2001), and Mars Odyssey (2001).

Ray is a member of the American Institute of Physics (AIP), the American Association of Physics Teachers (he still does some Physics!) and the American Institute of Astronautics and Aeronautics (AIAA). He serves as the IEEE Transactions Associate Editor for the EMC Journal, as Associate Editor for Book Reviews of the IEEE EMC Society Newsletter, and as the Editor-In-Chief of the ACES Newsletter. He has published papers in all of the above societies. He is a member of the National Society of Professional Engineers and a NARTE certified engineer. Ray has also served as adjunct faculty teaching Physics and Electrical Engineering.

PAST SERVICE TO ACES

My first involvement with ACES was with the Newsletter since 1990 as the Associate Editor. Since 1994 I have had the pleasure to serve ACES as the Editor-In-Chief of the ACES Newsletter, and a member of the ACES Editorial Board. The ACES Newsletter, with the tremendous help of excellent Associate Editors, has tried to serve the members of ACES for many years by tailoring our feature articles to the needs of our readers.

CANDIDATE'S PLATFORM

I have been involved in ACES since its early days in the 1980's and over the last eight years I have been the ACES Newsletter Editor. In talking about the past, the ACES Newsletter has come a long way under my leadership since its early days. Over the years we have tried to make the newsletter a publication where the voice of our highly diverse members are heard, on issues concerning computational electromagnetics. Interdisciplinary discussions, papers, and tutorials have been presented over many years, and I am particularly proud of having served as a conduit for making the ACES Newsletter a diverse publication. The ACES Newsletter will soon get new leadership, but the new leaders have promised me to continue on the road of diversity: a) diversity in the people who contribute to the newsletter, and b) diversity in the articles published.

In talking about the present, I would like to help guide ACES along its interdisciplinary roots, again this is also part of the diversity theme of which I am an advocate. Computational electromagnetics (CEM) is embedded in almost all the sciences and engineering fields, and I am convinced that the future of ACES is directly tied to how well we address the diverse needs and interests of our present and future members. In this path, I became the guest editor for a new special issue of the ACES journal on the role of CEM in wireless communication, published fall 2000. I would like to contribute to the interdisciplinary nature of ACES by expanding its role into areas of biology, process and manufacturing engineering, component engineering, design engineering (including software), medicine, astronomy, education,.etc.

OTHER UNIQUE QUALIFICATIONS Statement not supplied by candidate!

GENERAL BACKGROUND

OMAR M. RAMAHI received the BS degrees in Mathematics and Electrical and Computer Engineering from Oregon State University, Corvallis, OR in 1984. He received his M.S. and Ph.D. in Electrical and Computer Engineering in 1986 and 1990, respectively from the University of Illinois at Urbana-Champaign. From 1990-1993, Dr. Ramahi held a visiting fellowship position at the University of Illinois at Urbana-Champaign. From 1993 to 2000, he worked at Digital Equipment Corporation (presently, Compaq Computer Corporation), where he was member of the alpha server product development group. In August of 2000, he joined the faculty of the James Clark School of Engineering at the University of Maryland at College Park, where he is also a faculty member of CALCE Electronics Products and Systems Center.

Dr. Ramahi served as a consultant to several companies. He was instrumental in developing computational techniques to solve a wide range of electromagnetic radiation problems in the fields of antennas, high-speed devices and circuits and EMI/EMC. His interests include experimental and computational EMI/EMC studies, high-speed devices and interconnects, biomedical applications of electromagnetics, novel optimization techniques, interdisciplinary studies linking electromagnetic application with new materials. He has authored and co-authored over 80 journal and conference papers and presentations. He is a co-author of the book *EMI/EMC Computational Modeling Handbook* (Kluwer Academic, 1998). Dr. Ramahi is a Senior Member of IEEE and a member of the Electromagnetics Academy.

PAST SERVICE TO ACES

The candidate's past service to ACES includes presentation of papers, organization of special sessions for the ACES Symposia and participation as short course instructor.

CANDIDATE'S PLATFORM

The field of electromagnetism (EM) is probably one of the very few fields in applied science that has reached a high level of maturity. Computational electromagnetics, which is considered the applied side of electromagnetism, has witnessed an explosive growth in the past fifteen years. Today, we have numerical algorithms that can characterize wave-matter electromagnetic interaction with a high degree of accuracy and with sufficient speed. Despite the maturity in both theoretical and computational electromagnetics, the application of computational EM to new technological frontiers remain in its infancy. For instance, in the emerging field of nanotechnology, electromagnetism is expected to play a significant role. For computational EM practitioners, the primary challenge is in the fact that these new technologies are driven by strong interdisciplinary research teams that are typically devoid of computational EM experts. Interestingly enough, the classical EM practitioner paradigm has changed. Instead of using computational EM to solve known problems, we need to look at applications that can be designed by harvesting the power of EM with the aid of computational EM.

Having the vantage point of working with mechanical, electrical, and aerospace engineers in the emerging technologies, I have the advantage of identifying new and significant applications of computational EM and bring these applications to the EM community through ACES.

OTHER UNIQUE QUALIFICATIONS Statement not supplied by candidate!

CEM NEWS FROM EUROPE

Pat Foster

2000 was a good year in Europe for antenna and propagation engineers. Several of the Institutions which run Antenna and Propagation Conferences in Europe got together to run a Millenium Special at Davos, Switzerland. A large number of the papers were devoted to mobile communications and it seems as though every European University has at least one research student working in this field. There were a number of papers on CEM but it is perhaps more notable that the 'ordinary' European engineering firm is using CEM tools in much the same way as it uses Vector Network Analyzers - as an aid to productivity.

The conference attracted over 1000 delegates and was very efficiently run by a secretariat from the European Space Technical Centre (ESTEC) The Chairman, Dr Antoine Roederer, was also from ESTEC. In addition to the people, the papers, the conversations, there was snow!!

The most notable happening in CEM otherwise is the publication of a CAD benchmark involving a Vivaldi antenna. The magazine, Microwave Engineering Europe, sets a benchmark problem to software vendors every year. Up to 2000, these problems had been devices and components. The geometry of the printed Vivaldi antenna was set out in the October 2000 issue together with a list of required responses from the vendors - Return Loss over 0.5 to 18 GHz, field plots and radiation patterns at 10 GHz. In the issues of November 2000 and January 2001, six vendors provided responses. The measured results are yet to be published but the results published so far are very interesting. A great deal of information is provided and those interested should look at the magazine's website http://www.mwee.com where the above articles can be found.

The methods ranged through Finite Element (HFSS from ANSOFT), FTDT (EMPIRE from IMST and CONCERTO from Vector Fields), Finite Integration (CST), TLM (Micro-stripes from KCC) and Method of Moments (IE3D from ZELAND).

A major topic of interest is a comparison of the runtimes which are shown in Table 1.

Table 1 Runtimes

Method	Runtime (minutes)	Machine	No of cells
Finite Element	143	450 MHz Sun Ultra 4 processors 2 GB RAM	33,914
Finite Integration	64	800MHz PIII	Not quoted
FDTD (1)	14	600 MHz Athlon 256 MB RAM	430,000
TLM	42	650 MHz PIII 128 MB RAM	400,000
FDTD (2)	120	600 MHz PIII 384 MB RAM	2,500,000
MoM	1548	450 MHz PII 256 MB RAM	2724

The time domain methods (FDTD and TLM) have much shorter runtimes although they have many more cells in their models. The actual meshing of free space and the boundary conditions applied affect the number of cells and therefore the accuracy and runtime.

Although the measured results are not yet published, some comments can be made of the responses. Five out of six vendors provided very similar Return Loss plots. There are slight differences but these are very minor. All vendors provided field plots at 10 GHz which looked very similar. The radiation patterns were more difficult to compare as every vendor seemed to produce his own scale and type of plot not to mention definition of E and H plane. Most of the vendors obtained very similar shapes of radiation pattern although the crosspolar levels were quite different.

It would have been more helpful if the magazine had specified the output format (scale, type of plot, definition of E and H plane) so that the results could be more easily compared. Nevertheless, this was an interesting exercise by all concerned.

TECHNICAL FEATURE ARTICLE

POWER SERIES ANALYSIS OF WEAKLY NONLINEAR CIRCUITS

Donald D. Weiner[1]
Andrew L. Drozd[2]

ABSTRACT

This is the third in a series of articles that explores the analysis and modeling of nonlinear behaviors in circuits, devices, and receiver systems. Analytic and numerical methods can be developed to readily analyze complex nonlinearities from elemental formulations such as the weakly nonlinear series. The topics discussed are quite general and have application to such diverse areas as automatic control, broadcasting, cable television, communications, EMC, electronic devices, instrumentation, signal processing, and systems theory. The previous articles in this series discussed the nonlinear effects of intermodulation, spurious responses, desensitization, cross modulation, gain compression/expansion as well as the concepts of average power, available power and/or exchangeable power [1-3]. In this article, we discuss in greater depth the various nonlinear modes and mechanisms that may arise in practical systems and components that incorporate nonlinear devices.

INTRODUCTION

All circuits containing electronic components are inherently nonlinear. Nevertheless, the preponderance of analyses dealing with electronic circuits assumes linear behavior. This paradox exists because (1) linear circuits are characterized by linear equations that are relatively easy to solve, (2) many nonlinear circuits can be adequately approximated by equivalent linear circuits provided the input signals are sufficiently small, and (3) closed-form analytical solutions of nonlinear equations are not ordinarily possible.

One model of a nonlinear circuit that is readily analyzed is shown in Figure 1. Observe that this model consists of a zero-memory nonlinearity preceded and followed by isolated linear filters. Use of this model is referred to as the power series approach. The nonlinearity is characterized in the time domain by its power series coefficients $\{a_1, a_2, \ldots, a_N\}$ and is said to be weakly nonlinear when only the first few terms of the power series are needed to represent the nonlinear behavior. Typically the linear filters that model the linear circuits preceding and following the nonlinear portion of the electronic device are characterized in the frequency domain by their linear transfer functions H(f) and K(f).

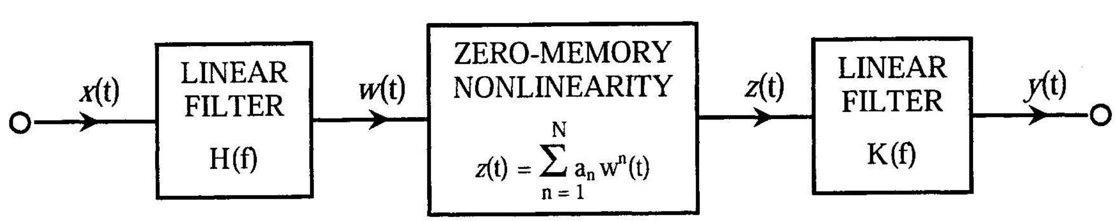


Figure 1. Power Series Model for a Nonlinear System With Memory

[1]Syracuse University, Link Hall, Syracuse, NY 13244, DDWEINER@ecs.syr.edu
[2]ANDRO Consulting Services, Beeches Technical Campus, Bldg. 3, Ste. 4, Rte. 26N, Turin Rd., Rome, NY 13440, androcs@borg.com

A system is said to have memory when the output at time *t* depends upon values of the input prior to time *t*. The nonlinearity in Figure 1 has zero memory because its output at a specific instant of time depends upon its input only at the same instant. Circuits containing energy storage elements have memory while purely resistive circuits have zero memory. Since the linear filters in Figure 1 are intended to be frequency selective, they contain energy storage elements. As a result, their outputs depend upon the past history of their inputs and the nonlinear system, as a whole, possesses memory.

The power series model is readily analyzed because the individual blocks shown in Figure 1 can be treated as isolated segments. Specifically, given the input $x(t)$, the output $w(t)$ of the first linear filter is readily obtained using conventional linear analysis. The output $z(t)$ of the zero-memory nonlinearity is then determined by substitution of $w(t)$ into the power series representation of the nonlinearity. Finally, the circuit output $y(t)$ is easily obtained as the response of the second linear filter to the known input $z(t)$. Thus, analysis of the power series model readily proceeds from input to output.

Although the power series model is an adequate representation for many electronic circuits, the reader is cautioned that this model is not universally applicable. A more general model is based upon the Volterra series or nonlinear transfer function approach [1]. However, the power series model does provide insight into the many nonlinear effects that occur in weakly nonlinear circuits [2].

Response of First Linear Filter

Allowing for the presence of interfering signals in addition to the desired signal, assume Q sinusoidal signals to be present at the input to the power series model shown in Figure 1. Hence,

$$x(t) = \sum_{q=1}^{Q} |E_q| \cos(2\pi f_q t + \theta_q). \qquad (1)$$

By introducing the complex amplitude

$$E_q = |E_q|\, e^{j\theta_q} \qquad (2)$$

and defining

$$E_{-q} = E_q^*, \; E_0 = 0, \; f_{-q} = -f_q, \qquad (3)$$

the excitation can be expressed as

$$x(t) = 1/2 \sum_{q=1}^{Q} \left[E_q e^{j2\pi f_q t} + E_q^* e^{-j2\pi f_q t}\right]$$
$$= 1/2 \sum_{q=-Q}^{Q} E_q e^{j2\pi f_q t}. \qquad (4)$$

The transfer function of the first linear filter in Figure 1 is denoted by

$$H(f) = |H(f)| e^{j\psi(f)}. \qquad (5)$$

Because the filter is linear, superposition applies. Consequently, its response is a sum of sinusoids at the same frequencies as those contained in the input. Each sinusoidal output magnitude at a particular frequency equals the corresponding input magnitude multiplied by the magnitude of the transfer function at that frequency while each output phase angle equals the corresponding input angle plus the phase angle of the transfer function at that frequency. In particular,

$$w(t) = \sum_{q=1}^{Q} |E_q|\, |H(f_q)| \cos\left[2\pi f_q t + \theta_q + \psi(f_q)\right] \qquad (6)$$

For real circuits the transfer function has the property that

$$H(-f) = H^*(f) = |H(f)|e^{-j\psi(f)}. \qquad (7)$$

As a result, *w*(t) can be written as

$$w(t) = 1/2 \sum_{q=1}^{Q} [E_q H(f_q) e^{j2\pi f_q t} + E_q^* H^*(f_q) e^{-j2\pi f_q t}]$$

$$= 1/2 \sum_{q=-Q}^{Q} E_q H(f_q) e^{j2\pi f_q t}. \qquad (8)$$

Response of Zero-Memory Nonlinearity

The output of the zero-memory nonlinearity is

$$z(t) = \sum_{n=1}^{N} a_n w^n(t). \qquad (9)$$

The n^{th} term in this sum is said to be of n^{th} degree because it involves *w*(t) raised to the n^{th} power. Focusing on the n^{th}-degree portion of *z*(t),

$$a_n w^n(t) = a_n/2^n \left[\sum_{q=-Q}^{Q} E_q H(f_q) e^{j2\pi f_q t} \right]^n =$$

$$a_n/2^n \sum_{q_1=-Q}^{Q} \cdots \sum_{q_n=-Q}^{Q} E_{q_1} \cdots E_{q_n} H(f_{q_1}) \cdots H(f_{q_n}) e^{j2\pi (f_{q_1}+\ldots+f_{q_n})t}. \qquad (10)$$

Consequently, Equation (9) can be written as

$$z(t) = \sum_{n=1}^{N} \sum_{q_1=-Q}^{Q} \cdots \sum_{q_n=-Q}^{Q} A_n(q_1,\ldots,q_n) e^{j2\pi(f_{q_1}+\ldots+f_{q_n})t} \qquad (11)$$

where

$$A_n(q_1,\ldots,q_n) = a_n/2^n E_{q_1} \cdots E_{q_n} H(f_{q_1}) \cdots H(f_{q_n}). \qquad (12)$$

Response of Second Linear Filter

Having obtained *z*(t), the final step in the analysis is determination of *y*(t), the output of the power series model. Note that this is also the response of the second linear filter whose transfer function is

$$K(f) = |K(f)|\, e^{j\phi(f)}. \qquad (13)$$

As was the case with the first linear filter, superposition applies and

$$y(t) = \sum_{n=1}^{N} \sum_{q_1=-Q}^{Q} \cdots \sum_{q_n=-Q}^{Q} B_n(q_1,\ldots,q_n) e^{j2\pi(f_{q_1}+\ldots+f_{q_n})t} \qquad (14)$$

where

$$B_n(q_1,\ldots,q_n) = A_n(q_1,\ldots,q_n) K(f_{q_1}+\ldots+f_{q_n}). \qquad (15)$$

Observe that the magnitude of $B_n(q_1,\ldots,q_n)$ is

$$|B_n(q_1,\ldots,q_n)| = a_n/2^n |E_{q_1}|\cdots|E_{q_n}|$$

$$|H(f_{q_1})|\cdots|H(f_{q_n})|\, |K(f_{q_1}+\ldots+f_{q_n})| \qquad (16)$$

while its angle is given by

$$\angle B_n(q_1,\ldots,q_n) =$$

$$\theta_{q_1}+\ldots+\theta_{q_n} + \psi(f_{q_1}) +\ldots+ \psi(f_{q_n}) + \phi(f_{q_1}+\ldots+f_{q_n}). \qquad (17)$$

The most striking feature concerning the response, as given by Equation (14), is the presence of new frequencies not contained in the input. Terms involving these new frequencies are referred to as inter-modulation components. Their complex amplitudes depend upon the complex input amplitudes, the power series coefficients, and the linear transfer functions of the two filters evaluated at the appropriate frequencies.

Because $E_0 = 0$, each sum in the n-fold summation of Equation (10) contains 2Q terms. Consequently, the total number of terms in the n^{th}-degree portion of $z(t)$ is $(2Q)^n$. This number grows rapidly with increasing values of Q and n. The number of terms in $y(t)$ is identical to that of $z(t)$. As a result, evaluation of all of the terms in Equation (14) is extremely tedious. Simplification of this expression is discussed next.

Total Response for a Particular Frequency Mix

Intermodulation components whose frequencies fall well outside of the system passband are usually not troublesome because they are greatly attenuated by the frequency selectivity of the system. Thus, with regard to Equation (14), it is necessary to focus only on those terms whose frequencies fall either within or close to the system passband.

For example, consider a system tuned to 50 MHz with a 1 MHz bandwith. Assume the input to consist of two interfering sinusoids at $f_1 = 46$ MHz and $f_2 = 48$ MHz. If the system contains a nonlinearity, an intermodulation component at $2f_2 - f_1 = 50$ MHz may be generated. This falls at the tuned frequency and may cause significant interference with the desired signal when the amplitudes of the interfering tones are sufficiently large. On the other hand, the intermodulation component whose frequency is $2f_1 + f_2 = 140$ MHz falls will outside of the system passband and may be ignored.

Therefore, the first step in evaluating Equation (14) is to determine which intermodulation frequencies are of concern. Having done this, the second step is to determine the manner by which the pertinent intermodulation frequencies are generated. For this purpose, the concept of a frequency mix is introduced.

A frequency mix is characterized by the number of times the various frequencies appear in the frequency sum $(f_{q_1}+\ldots+f_{q_n})$ of Equation (14). For example, consider a power series model for which N = 5. Focus on the intermodulation frequency given by $2f_2 - f_1$. Corresponding to n=3, $2f_2 - f_1$ is produced by the single frequency mix $(f_2 + f_2 - f_1)$. Corresponding to n=5, $2f_2 - f_1$ is produced by the two frequency mixes $(f_2 + f_2 + f_2 - f_2 - f_1)$ and $(f_2 + f_2 + f_1 - f_1 - f_1)$.

As far as frequency mixes are concerned, the order in which the frequencies appear is unimportant. For example, $(f_2 - f_1 + f_2)$ represents the same mix as does $(-f_1 + f_2 + f_2)$ and $(f_2 + f_2 - f_1)$. What is important is the number of times each frequency appears in the mix. Note that $(f_2 + f_2 - f_1)$ involves $-f_1$ once and f_2 twice, $(f_2 + f_2 + f_2 - f_2 - f_1)$ involves $-f_2$ once, $-f_1$ once, and f_2 three times, while $(f_2 + f_2 + f_1 - f_1 - f_1)$ involves $-f_1$ twice, f_1 once, and f_2 twice.

The concept of a frequency mix has been introduced in order to clarify the manner by which an intermodulation frequency is produced. To avoid confusion, frequency mixes, such as $(f_2 + f_2 + f_1 - f_1 - f_1)$, are enclosed in parentheses while intermodulation frequencies, such as $2f_2 - f_1$, are not.

To aid in the representation of a frequency mix, let the number of times that the frequency f_k appears be denoted by m_k. Considering negative frequencies, recall that $f_{-k} = -f_k$. Therefore, for an excitation consisting of Q sinusoidal tones, as given by Equations (1) and (4), the input frequencies are $f_{-Q},\ldots,f_{-1}, f_1,\ldots,f_Q$. It follows that any possible frequency mix can be represented by the frequency mix vector

$$\underline{m} = (m_{-Q},\ldots,m_{-1}, m_1,\ldots,m_Q). \qquad (18)$$

By way of example, assume Q = 2 corresponding to the four input frequencies f_{-2}, f_{-1}, f_1, f_2 and the frequency mix vector

$$\underline{m} = (m_{-2}, m_{-1}, m_1, m_2). \qquad (19)$$

The frequency mix $(f_2 + f_2 - f_1)$ is represented by $\underline{m}$ = (0, 1, 0, 2) while $\underline{m}$ = (1, 1, 0, 3) represents the frequency mix $(f_2 + f_2 + f_2 - f_2 - f_1)$ and $\underline{m}$ = (0, 2, 1, 2) represents the frequency mix $(f_2 + f_2 + f_1 - f_1 - f_1)$.

In general, the nth-order frequency mix $(f_{q_1}+\ldots+f_{q_n})$, as appears in Equation (14), can be expressed as

$$f_{\underline{m}} = \sum_{\substack{k=-Q \\ k\neq 0}}^{Q} m_k f_k$$

$$= m_{-Q}f_{-Q}+\ldots+m_{-1}f_{-1} + m_1f_1+\ldots+m_Qf_Q. \qquad (20)$$

Since exactly n frequencies are involved in an nth-order frequency mix, it follows that

$$\sum_{\substack{k=-Q \\ k\neq 0}}^{Q} m_k = m_{-Q}+\ldots+m_{-1} + m_1+\ldots+m_Q = n. \qquad (21)$$

With regard to the n indices $q_1,\ldots,q_n$ of Equation (14), observe that $B_n(q_1,\ldots,q_n)$ and $(f_{q_1}+\ldots+f_{q_n})$ are unchanged by a permutation of the indices. Consequently, many of the terms in Equation (14) are identical. Corresponding to a particular frequency mix vector $\underline{m}$, it can be shown that the number of identical terms is given by the multinomial coefficient

$$(n; \underline{m}) = (n!)/[(m_{-Q}!)\ldots(m_{-1}!)(m_1!)\ldots(m_Q!)]. \qquad (22)$$

For example, consider the frequency mix $(f_2 + f_2 + f_2 - f_2 - f_1)$ for which n = 5 and $\underline{m}$ = (1, 1, 0, 3). Using Equation (22), the number of identical terms in Equation (14) contributing to this mix is

$$(5; 1, 1, 0, 3) =$$

$$(5!)/[(1!)\,(1!)(0!)(3!)] = 20. \qquad (23)$$

Combining all of these terms, the resulting intermodulation component is given by

$$y_5\,(t; 1, 1, 0, 3) =$$

$$20a_5/32[E_2^*E_1^*E_2^3 H^*(f_2)\, H^*(f_1)H^3(f_2)\, K(2f_2 - f_1)\, e^{j2\pi(2f_2 - f_1)t}]. \qquad (24)$$

In general, let the sum of identical terms corresponding to a particular frequency mix vector $\underline{m}$ of order n be denoted by $y_n(t; \underline{m})$. It follows that $y_n(t; \underline{m})$ can be expressed as

$$y_n\,(t; \underline{m}) =$$

$$\frac{(n; \underline{m})\, a_n}{2^n} (E_Q^*)^{m_{-Q}} \ldots (E_1^*)^{m_{-1}} (E_1)^{m_1} \ldots (E_Q)^{m_Q}$$

$$\left[H^*(f_Q)\right]^{m_{-Q}} \ldots \left[H^*(f_1)\right]^{m_{-1}} \left[H(f_1)\right]^{m_1} \left[H(f_Q)\right]^{m_Q}$$

$$K(f_{\underline{m}})e^{j2\pi f_{\underline{m}} t} \qquad (25)$$

Although $y_n(t; \underline{m})$ is complex, $y(t)$ is real. Therefore, terms in Equation (14) exist in conjugate pairs.

Characterization of a nonlinear electronic circuit by the power series model requires specification of the prefilter transfer function H(f), the postfilter transfer function K(f), and the power series coefficients $\{a_1, a_2, \ldots, a_N\}$. When accurate predictions of the nonlinear responses are desired, one might expect that accurate modeling of the power series coefficients is the most critical task. Equation (25) reveals that this is not the case. The prefilter transfer function H(f) appears as a factor n times whereas the power series coefficient a_n and the postfilter transfer function K(f) appear only once. As a result, errors in the modeling of H(f) may be much more serious than similar errors in the modeling of a_n and K(f). Because of the accuracy to which H(f) must be known in order to stay within a prescribed output error, it may be exceedingly difficult to make accurate predictions of nonlinear responses when n is large.

SUMMARY

This article discussed the characterization of weakly nonlinear electronic circuits by the power series modeling approach. This approach requires the specification of prefilter and postfilter transfer functions, and the power series coefficients. The responses of the first and second linear filters, zero-memory nonlinearities, and the total response for a particular frequency mix were mathematically described. It was shown that because of the accuracy to which the prefilter transfer function must be known in order to stay within a prescribed output error, it may be exceedingly difficult to make accurate predictions of nonlinear responses when the number of terms, n, to be considered is large. In the next article in this series, we will continue to discuss the various nonlinear modes and mechanisms that arise in practical systems. The series will conclude with a presentation on new findings of research and development to add nonlinear analysis and prediction capabilities to existing CEM tools that are used to determine detailed interference rejection requirements for large, complex systems.

REFERENCES

1. D. D. Weiner and J. F. Spina, "*Sinusoidal Analysis and Modeling of Weakly Nonlinear Circuits*", Van Nostrand Reinhold Company, New York 1980, ISBN 0-442-26093-8.
2. D. D. Weiner, A. L. Drozd, K. V. Sunderland, and I. Popitich, "*Analysis and Modeling of Weakly Nonlinear Systems*", Newsletter Technical Feature Article for the Applied Computational Electromagnetics Society, Vol. 15, No. 1, ISSN 1056-9170, March 2000, pp. 9-15.
3. D. D. Weiner and A. L. Drozd, "*Power Considerations for the Measurement of Nonlinear Effects*", Newsletter Technical Feature Article for the Applied Computational Electromagnetics Society, Vol. 15, No. 2, ISSN 1056-9170, July 2000, pp 13-18.

Perspectives in CEM

Note: The Perspectives in CEM column will now be written by Professor Manos Tentzeris. To introduce him to our readers, below is a short description of himself and his main interests.

Prof. Manos M. Tentzeris is an Assistant Professor with Georgia Tech, Atlanta, GA. He has helped develop academic programs in Time-Domain Numerical Electromagnetics, RF and Wireless Applications and Microwave MEMS design and optimization and he is looking forward to collecting some interesting articles from these communities. He is particularly interested in:

(i) The Development of Adaptive Gridding Algorithms used for the Analysis and Design of Complex Microwave Packaging Geometries (e.g. Flip-Chip, Embedded Passives) widely used in modern Wireless Communication Systems.

(ii) The Application of Multiresolution Analysis to the design of RF Micromechanical Structures (MEMS) involving the coupling of Electromagnetic and Mechanical Phenomena.

(iii) The Time-Domain Numerical optimization of SPICE-type Circuits containing nonlinear elements (e.g. Diodes, Transistors) and Transient Phenomena, that require the combination of EM and Solid-state equations,

but he will consider any interesting topic or position you might like to present. His contact is:

Manos M. Tentzeris, Ph.D.
Assistant Professor
School of Electrical and Computer Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0250
Ph. Num: (404) 385-0378
FAX Num: (404) 894-4641

INTRODUCTION TO THE METHOD OF MOMENTS TECHNIQUE

Bruce Archambeault
IBM

Background

This article provides a brief introduction to the Method of Moments (MoM) technique. There are many articles and books written on this topic. This is intended to provide a quick overview for a reader interested in understanding the basic technique. For a more complete description of MoM the reader is referred to the many publications available.

The technique described here is more properly called the Boundry Element Technique (BEM), since the Method of Moments is a broader term and includes many techniques called by othe rnames. While the term "Method of Moments" is commonly used to mean the Boundry Element Method, to avoid confusion, the Method of Moments term is used here.

The Method of Moments technique (also called Moment-method technique) have become very popular in the past 30 years or so. MoM algorithms are generally run on high speed workstation or mainframe computers, but they can be used to model a wide variety of problems without requiring the user to assume a particular current distribution. MoM is used extensively to model radar cross section and antenna applications, and has recently been applied to EMI/EMC problems.

The structure to be modeled is converted into a series of metal plates and wires. In fact, often a solid structure is converted into a wire frame model, eliminating the metal plates. Once the structure is defined, the wires are broken into wire segments (short compared to a wavelength so the assumption of constant current on that segment is valid) and the plates are divided into patches (small compared to a wavelength so the assumption of constant current on that patch is valid). From this structure, a set of linear equations is created. The solution to this set of linear equations is the RF currents on each wire segment and surface patch. Once the RF current is known for each segment and patch, the electric field at any point in space can be determined by solving for each segment/patch and performing the vector summation.

The Basics of MoM

MoM actually refers to a general procedure for solving linear mathematical equations of the form,

$$L(\vec{f}) = \vec{E} \qquad (1)$$

where L is a linear operator f is an unknown response and E is a known excitation. [1][2][3] For electromagnetic modeling, the known excitation is usually an imposed electric or magnetic field, and the unknown response is generally a current distribution. Once the currents are known everywhere on the structure, the electric and magnetic fields can be found at any point in space. The equation relating the currents and fields is known as the electric field integral equation (EFIE) when the know excitation is an electric field or the magnetic field integral equation (MFIE) when the excitation is a magnetic field. The relative usefulness and accuracy of a particular MoM model depends, in part, on the assumptions made in the process of deriving the integral equation and whether EFIE or MFIE is used. For EMI/EMC modeling, the source is usually an applied voltage (modeled as an electric field across a short distance), so the EFIE is typically used.

The first step in the MoM solution process is to describe the unknown response (in this case the current distribution) as a finite sum of basis functions,

$$\vec{f} = \sum_{j=1}^{N} \alpha_j \vec{f}_j \qquad (2)$$

where: f_j = the j^{th} basis function
α_j = unknown coefficient

Using this approximation the entire current distribution can now be solved by finding the values for the N coefficients, α_j.

The second step in the MoM procedure is to define a set of weighting functions, w_i, which may or may not be the same as the basis functions. Defining the inner product as,

$$\langle A, B \rangle \equiv \oint_S (A \bullet B)\, ds \qquad (3)$$

where s is the entire surface on which A and B are defined. We can then take the inner product of (1) with each of the chosen weighting functions,

$$\langle \vec{w}_i, L(\vec{f}) \rangle = \langle \vec{w}_i, \vec{E} \rangle \quad i = 1,2,\ldots N \qquad (4)$$

Using the linearity of L and making the substitution in equation (2),

$$\sum_{j=1}^{N} \alpha_j \langle \vec{w}_j, L(\vec{f}_j) \rangle = \langle \vec{w}_i, \vec{E} \rangle \qquad (5)$$

Setting:

$$\vec{Z}_{ij} = \langle \vec{w}_i, L(\vec{f}_j) \rangle$$
$$\vec{I}_j = \alpha_j$$
$$\vec{E}_j = \langle \vec{w}_i, \vec{E} \rangle$$

And converting to matrix notation:

$$[\vec{Z}][\vec{I}] = [\vec{E}] \qquad (6)$$

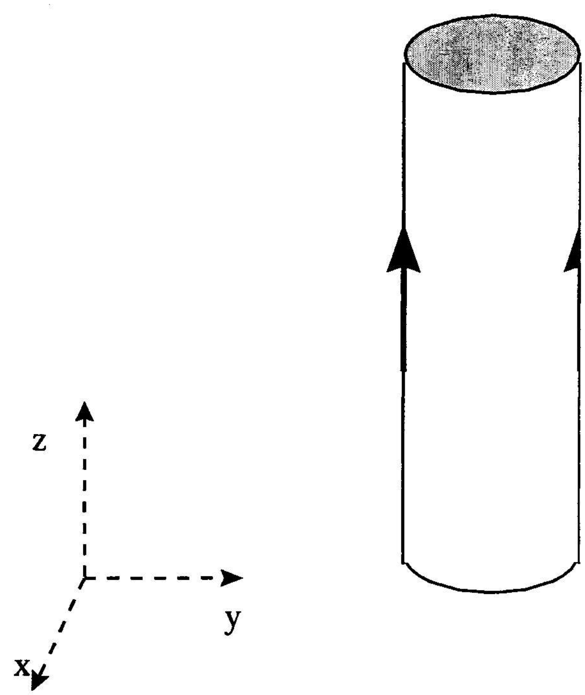


Figure 1 MoM Geometry for Current on a Wire Segment

The only unknown quantity in equation (6) is I, which is a vector containing the N coefficients describing the current distribution. Provided the matrix Z is not singular (that is, the problem has a unique solution), it is possible to solve for I in equation (6) as shown in equation (7).

$$[\vec{I}] = [\vec{Z}]^{-1}[\vec{E}] \qquad (7)$$

Therefore, the current on a particular segment in the model is found from the contribution of the source, and the contribution from all other currents in the model. Equation (7) represents a set of N linear equations, with N unknowns.

Filling the Impedance Matrix

Once the basics of MoM are understood, the next task is to fill the impedance matrix, then the MoM solution simply requires inverting [Z] and a matrix multiplication with the source. Although there are a number of different formulations to find [Z], this work used a thin-wire formulation called Pocklington's integral equation. In general, the electric field from a current is given by

$$\vec{E}(r) = -j\omega\,\vec{A} - j\frac{1}{\omega\mu\varepsilon}\nabla(\nabla \bullet \vec{A}) = -j\frac{1}{\omega\mu\varepsilon}\left(\omega^2\mu\varepsilon\,\vec{A} + \nabla(\nabla \bullet \vec{A})\right) \qquad (8)$$

where:

$$\vec{A}(r) = \mu \iint_S \vec{J}_S(r')\frac{e^{-j\beta R}}{4\pi R}ds' \qquad (9)$$

However, since the observation of the current is only along the surface, and only the z component is needed (see Figure 1) equation (8) is re-written as:

$$E_z(r) = -j\frac{1}{\omega\mu\varepsilon}\left(\beta^2 A_z + \frac{\partial^2 A_z}{\partial z^2}\right) \qquad (10)$$

and with only the z component equation (9) becomes:

$$A_z = \frac{\mu}{4\pi}\int_{-l/2}^{l/2}\int_0^{2\pi} J_z \frac{e^{-j\beta R}}{R} a\, d\phi'\, dz' \qquad (11)$$

since the wire is assumed to be thin (λ>>a), the current density J_z is not a function of the azimuth angle ϕ, and the current density becomes:

$$J_z = \frac{1}{2\pi a} I_z(z') \qquad (12)$$

where I_z is assumed to be an equivalent filament line current located on the wire segment's surface. Therefore,

$$A_z = \frac{\mu}{4\pi}\int_{-l/2}^{l/2}\left[\frac{1}{2\pi a}\int_0^{2\pi}\frac{e^{-j\beta R}}{R} a\, d\phi'\right]dz' \qquad (13)$$

$$R = \sqrt{(x-x')^2 + (y-y')^2 + (z-z')^2}$$
$$R = \sqrt{\rho^2 + a^2 - 2\rho\, a\cos(\phi-\phi') + (z-z')^2} \qquad (13a)$$

where ρ is the radial distance to the observation point and a is the radius.

Since the wire segment is symmetrical about ϕ, the observation of the current is not a function of ϕ, so ϕ=0 will be substituted into equation (13). Since the observation of the current is on the surface of the wire, ρ=a, and equation (13) becomes,

$$A_z(\rho = a) = \mu\int_{-l/2}^{l/2} I_z(z')\, G(z,z')\, dz' \qquad (14)$$

$$G(z,z') = \frac{1}{2\pi}\int_0^{2\pi}\frac{e^{-j\beta R}}{4\pi R} d\phi' \qquad (14a)$$

$$R(\rho = a) = \sqrt{4a^2 \sin^2\left(\frac{\phi'}{2}\right) + (z-z')^2} \qquad (14b)$$

where equation (14a) is a Green's Function. Combining equations (10) and (14), the electric field is

$$E_z = -\frac{1}{j\omega\varepsilon}\int_{-l/2}^{l/2} I(z')\left[\left(\frac{d^2}{dz^2}+\beta^2\right)G(z,z')\right]dz' \qquad (15)$$

Equation (15) is referred to as Pocklington's integrodifferential equation [4], and it is used to determine the current along the surface of the wire, given an incident electric field.

As mentioned earlier, the selected weighting function varies depending upon the requirements for the modeling. If the segment length is kept electrically small (1/10th wavelength or shorter), then the point-matching method is commonly used for a weighting function. That is, the current is assumed to only exist on the center of the wire segment as a delta function. Since

$$\int_{-\infty}^{\infty} I_z \cdot \delta(z=z_0)dz \;= I_z(z=z_0) = I_{z=z0} \qquad (16)$$

equation (15) can be reduced to

$$E_z = -\frac{1}{j\omega\varepsilon} I(z'_{z0}) \int_{-l/2}^{l/2} \left[\left(\frac{d^2}{dz^2}+\beta^2\right)G(z,z')\right]dz' \qquad (17)$$

Also, since we assume the wire segment is very thin (a<<λ), then equation (14a) reduces to

$$G(z,z') = G(R) = \frac{e^{-j\beta R}}{4\pi\, R} \qquad (18)$$

Recall in Equation (6) the electric field was a function of the unknown current and the impedance. Equation (17) fills this function, and the impedance matrix can be created, allowing the currents to be found.

Finding the Electric Fields from the RF Currents

Once the currents are known, the electric and magnetic fields can be found at any point in space (due to those currents), by using the Herzian dipole equations. The wire segments must be electrically short (λ>>L), but this requirement is necessary for the MoM technique and is already implemented. The general electric fields can be found using Equations (19) and (20).

$$E_r = \frac{IL\cos\theta}{2\pi\varepsilon_0}\left(\frac{1}{cr^2}+\frac{1}{j\omega\, r^3}\right) \qquad (19)$$

$$E_\theta = \frac{IL\sin\theta}{4\pi\,\varepsilon_0}\left(\frac{j\omega}{c^2 r}+\frac{1}{cr^2}+\frac{1}{j\omega\, r^3}\right) \qquad (20)$$

Summary

The MoM technique is a fairly straightforward and intuitive technique. Creating a wire structure, finding the current distribution over the entire structure, and then finding the fields due to those currents is intuitive to most engineers. The MoM technique requires the creation of a system of N linear equations with N unknowns, where each unknown is the current on a single segment. The unknown currents are solved by using matrix techniques. Once the current is known, the fields can be found using the Herzian dipole equations.

References

[1] C.T.A. Johnk, *Engineering Electromagnetic Fields* and Waves, Wiley, 1988

[2] R.F. Harrington, *Field Computation by Moment Methods*, Krieger Publishing Company, 1985

[3] T.H. Hubing, "Modeling the Electromagnetic Radiation from Electrically Small sources with Attached Wires," Ph.D. Dissertation, North Carolina State University, 1988

[4] C.A. Balanis, *Advanced Engineering Electromagnetics*, Wiley, 1989, Sect. 12.4.1.

Call for Papers

The Applied Computational Electromagnetics Society

Announces a Special Issue of the ACES Journal on:

Approaches to Better Accuracy/Resolution In Computational Electromagnetics

The Applied Computational Electromagnetics Society is pleased to announce the publication of a Special Issue of the ACES Journal on advances in methods and applications that address issues that improve accuracy, resolution and/or convergence in solving present day computational electromagnetic problems. The objectives of this special issue are to present such advances, reviews and/or comparisons of methods. Prospective authors are encouraged to submit papers that address these objectives and other suggested topics listed below.

Suggested Topics:

- Alternative Approaches to the Method of Moments
  - Nystrom
  - Boundary Residual Method
- New, improved basis functions
- Use of non-uniform interval selection for:
  - Collocation
  - Sub-domain basis/testing functions
- Convergence Acceleration Methods
- Comparison of computer cost/time
  - For given levels of convergence
  - For different basis functions
- Methods for numerical evaluation of frequently encountered integrals
- Exponentially Converging Green's function summation formulae
- Toward 'dialable' accuracy in computational Electromagnetics

DEADLINE FOR PAPERS IS MAY 1, 2001

Potential contributors wishing to discuss the suitability of their contribution may contact either of the Guest Editors listed below. The review process will commence as either editor receives papers. Notification of accepted papers will be made as papers are reviewed. Please send manuscripts to either Guest Editor:

Professor Andrew F. Peterson
School of Elec. & Comp. Engineering
Georgia Institute of Technology
777 Atlantic Drive
Atlanta, GA 30332, USA
Tel: 404-894-4697
Fax: 404-894-5935
email: peterson@ee.gatech.edu

Malcolm M. Bibby
c/o Gullwings Design
47 Whitney Tavern Road
Weston, MA 02493, USA
Tel: 781-891-8949
email: bibby@ne.mediaone.net

Call for Papers

The Applied Computational Electromagnetics Society

Announces a Special Issue of the ACES Journal on:

Adaptive Refinements and A-Posteriori Error Estimates in PDEs for Computational Electromagnetics

The Applied Computational Electromagnetics Society is pleased to announce the publication of a Special Issue of the ACES Journal on advances in PDE methods that address issues involving a-posteriori error estimates of the numerical solution as well as adaptive procedures to improve solutions accuracy in solving present day computational electromagnetic problems. Research works that relate to adaptive mesh refinements, h-version, p-version and the hp-version of mesh refinement are of particular interests. Prospective authors are encouraged to submit papers that address these activities and other suggested topics listed below.

Suggested Topics:

- Higher order basis functions and treatments of singularities
- A-priori and A-posteriori error estimates of PDE methods for solving Maxwell's equations
- Fast matrix solution techniques
  - Direct methods with new unknown ordering schemes
  - Iterative methods for faster convergence
  - Investigation of validity of iterative methods for solving matrix equations from discretization of Maxwell's equations
- Adaptive mesh refinement
  - h-, p-, and hp-adaptive mesh refinements for PDE methods in Computational Electromagnetics
  - Automatic methods for generating finer grids based on refinement indexes
  - Mesh generation methods that improve the quality of the discretization
- Mesh truncation methods and their accuracies
- Multigrid methods and their applications to adaptive procedures in PDEs for Computational Electromagnetics

DEADLINE FOR PAPERS IS July 1, 2001

Potential contributors wishing to discuss the suitability of their contribution may contact either of the Guest Editors listed below. The review process will commence as either editor receives papers. Notification of accepted papers will be made as papers are reviewed. Please send manuscripts to either Guest Editor:

Professor Jin-Fa Lee
Dept. of Electrical Engineering
ElectroScience Laboratory
The Ohio State University
1320 Kinnear Rd.
Columbus, OH 43212
Tel: 614-292-7270
Fax: 614-292-7297
email: jinlee@ee.eng.ohio-state.edu

Professor Robert Lee
Dept. of Electrical Engineering
ElectroScience Laboratory
The Ohio State University
1320 Kinnear Rd.
Columbus, OH 43212
614-292-1433
614-292-7297
lee@ee.eng.ohio-state.edu

THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

CALL FOR PAPERS

The 18th Annual Review of Progress in Applied Computational Electromagnetics

March 18-23, 2002

Naval Postgraduate School, Monterey, California

"Share Your Knowledge and Expertise with Your Colleagues"

The Annual ACES Symposium is an ideal opportunity to participate in a large gathering of EM analysis enthusiasts. The purpose of the Symposium is to bring analysts together to share information and experience about the practical application of EM analysis using computational methods. The symposium offerings include technical presentations, demonstrations, vendor booths and short courses. All aspects of electromagnetic computational analysis are represented. Contact for details:

Technical Program Chairman
Ross Speciale
Search and Development, Inc.
639 Camino de Encanto
Redondo Beach, CA 90277-6535
Phone: 310-375-1287
Email:rspeciale@socal.rr.com

Symposium Administrator
Richard W. Adler
ECE Dept, Code EC/AB
Naval Postgraduate school
Monterey, CA 93943-5121
Phone: (831)646-1111
Fax: (831)649-0300
Email:rwa@attglobal.net

The ACES Symposium is a highly influential outlet for promoting awareness of recent technical contributions to the advancement of computational electromagnetics. Attendance and professional program paper participation from non-ACES members and from outside North America are encouraged and welcome.

*The exact fee will be announced later. Each conference registration is entitled to publish two papers in the proceedings free of charge. Excess pages over a paper limit of 8 will be charged $25/page.

2002 ACES Symposium

Sponsored by:	ACES, NAVAL POSTGRADUATE SCHOOL
in cooperation with:	The IEEE Antennas and Propagation Society, the IEEE Electromagnetic Compatibility Society and USNC/URSI

Visit ACES on line at: www.emclab.umr.edu/aces and http://aces.ee.olemiss.edu

THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

CALL FOR PAPERS

The 18th Annual Review of Progress in Applied Computational Electromagnetics

March 18-23, 2002

Papers may address general issues in applied computational electromagnetics, or may focus on specific applications, techniques, codes, or computational issues of potential interest to the Applied Computational Electromagnetics Society membership. Area and topics include:

- Code validation
- Code performance analysis
- Computational studies of basic physics
- Examples of practical code application
- New codes, algorithms, code enhancements, and code fixes
- Computer Hardware Issues
- Partial list of applications:

antennas	wave propagation
radar imaging	radar cross section
shielding	bioelectromagnetics
EMP, EMI/EMC	visualization
dielectric & magnetic materials	inverse scattering
microwave components	MIMIC technology
fiberoptics	remote sensing & geophysics
communications systems	propagation through plasmas
eddy currents	non-destructive evaluation

- Partial list of techniques:

frequency-domain & time-domain techniques
integral equation & differential equation techniques
finite difference & finite element analysis

diffraction theories	physical optics
modal expansions	perturbation methods
hybrid methods	moment methods

PRELIMINARY INSTRUCTIONS FOR AUTHORS AND TIMETABLE

THESE DATES ARE SUBJECT TO CHANGE

November 15, 2001: Submission deadline. Electronic Submission required (PDF or Postscript formats) of full photo-ready finished paper. Format specifications & additional details will be found in the next paragraph, and later on, on the ACES website at:http://aces.ee.olemiss.edu. Submit to Technical Program Chairman. Please supply the following data for the corresponding author: name, address, email address, FAX, and phone numbers. See below for instructions for the format of paper.

December 01, 2001: Authors notified of acceptance.

PAPER FORMATTING REQUIREMENTS

The recommended paper length is 6 pages, with 8 pages as a maximum, including figures. The paper should be camera-ready (good resolution, clearly readable when reduced to the final print of 6 x 9 inch paper). The paper should be printed on 8-1/2 x 11 inch papers with 13/16 side margins, 1 inch top margin, and 1 inch on the bottom. On the first page, place title 1 inch from top with author and affiliation beneath the title. Single spaced type using 10 or 12 point front size, entire text should be justified (flush left and flush right). Do not place **page numbers except on backs of paper, using pencil. Authors using A4 Size paper should follow similar guidelines: on the first page, place title 2.5 cm from top with author and affiliation beneath the title; 1/75 cm side margins; 2.5 cm top margin; and 2.5cm on bottom margin.**

SHORT COURSES/HANDS-ON-WORKSHOP

Short courses and Hands-on-Workshops will be offered in conjunction with the Symposium covering numerical techniques, computational methods, surveys of EM analysis and code usage instruction. It is anticipated that short courses and hands-on-workshops will be conducted on Monday and Friday.

EXHIBITS

Vendor booths and demonstrations will feature commercial products, computer hardware and software demonstrations, and small company capabilities.

PRELIMINARY AGENDA

The 17th Annual Review of Progress in Applied Computational Electromagnetics
Naval Postgraduate School
19-23 March 2001

Technical Program Chair – Leo Kempel, Symposium Co-Chairs - Edward Rothwell and Douglas Werner
Electronic Publication Chair – Atef Elsherbeni, Vendor Chair – Tim Holzheimer, Symposium Administrator – Richard Adler
Short Course Chair – John Schaeffer, Publicity Chair – Keith Lysiak, Conference Secretary – Pat Adler

MONDAY MORNING 19 MARCH 2001

0700 – 0730 **CONTINENTAL BREAKFAST** – (For Short Course and Workshop attendees only) **Glasgow Courtyard**

0730 – 0820 **SHORT COURSE/HANDS-ON-WORKSHOP REGISTRATION** **Glasgow 103**

0830 - 1630 **SHORT COURSE #1 (FULL-DAY) - "Computational Electromagnetic Methods in Mobile Wireless Communication Design"**
Ray Perez, Jet Propulsion Laboratory **IN 122**

0830 - 1630 **SHORT COURSE #2 (FULL-DAY) - "The Finite Difference Time Domain Technique for Electromagnetic Application"**
Atef Z. Elsherbeni and Allen W. Glisson, University of Mississippi **GL 102**

0830 – 1630 **SHORT COURSE #3 (FULL-DAY) - "EMI/EMC Computational Modeling for Real-World Engineering Problems"**
Omar Ramahi, University of Maryland and Bruce Archambeault, IBM **ME Aud**

0830 - 1630 **SHORT COURSE #4 (FULL-DAY) - "Scripting Electromagnetics Simulators in PYTHON"**, Eric Jones, Duke University **IN 366**

0830 -1630 **SHORT COURSE #5 (FULL-DAY) - "Electromagnetic Visualization"**, John Shaeffer, Marietta Scientific **SP 101A**

MONDAY AFTERNOON

1400 – 1700 **CONFERENCE REGISTRATION** **Glasgow 103**

1730 **BOARD of DIRECTORS MEETING** **101A Spanagel Hall**

MONDAY EVENING

1900 **PUBLICATIONS COMMITTEE DINNER**

TUESDAY MORNING 20 MARCH 2001

0715 – 0745 **CONTINENTAL BREAKFAST** **Glasgow Courtyard**

0745 **ACES BUSINESS MEETING** **President Perry Wheless** **GL 102**

0800 **WELCOME** **Leo Kempel**, Michigan State University **GL 102**

0815 **PLENARY SPEAKER:** **Dr. David Koo**, Phillips Research Lab **GL 102**
"Computational Electromagnetics: What Do We Need for Tomorrow?"

SESSION 1: STUDENT PAPER COMPETITION **(No Parallel Sessions)** **GL 102**
Chair: Perry Wheless

0920 "Adaptive Numerical Modeling of RF Structures Requiring the Coupling of Maxwell's, Mechanical, and Solid-State Equations", N. Bushyager, B. McGarvey, & M.M. Tentzeris

0940 "Numerical Boundary Conditions at Material Interfaces for High-Order FDTD Schemes" K-P Hwang & A.C. Cangellaris

1000 "Mixed-mode Parallel Computations Applied to Paraxial Optics Involving a Thermally Self-Induced Inhomogeneous Medium", J.S. Hammonds, F. Saied, & M.A. Shannon

1020 "Some Aspects of Dispersion Analysis of Multiresolution", C.D. Sarris & L.P.B. Katehi

1040 "Performance Estimation for Conformal Phased Array Antennas for Given Gain and Pattern Requirements", D. Löffler & W. Wiesbeck

1100 **BREAK**

1120 "Hybrid Finite Element-Boundary Integral Method for Conformal Antennas on Prolate Spheroids: Preliminary Results"
C. Macon & L.C. Kempel

1140 "Optimized Frequency Selective Surface Designs as Artificial Substrates for Reconfigurable Arrays"
Y.E. Erdemli, Z. Li, D.E. Wright, R.A. Gilbert, & J.L. Volakis

1200 "A Self-Similar Fractal Radiation Pattern Synthesis Technique for the Design of Multi-Band and Broad-Band Arrays"
M.A. Gingrich, D.H. Werner, & P.L. Werner

TUESDAY 20 MARCH 2001

SESSION 1: STUDENT PAPER COMPETITION (cont) **GL 102**

1220 "A Radiation Pattern Synthesis Technique for Conformal Antenna Arrays Mounted on Truncated PEC Circular Cylinders" R.J. Allard, D.H. Werner, & PL. Werner

1240 "Hierarchical Finite Element Basis Function Spaces for Tetrahedral Element", Y. Zhu & A. Cangellaris

1300 **LUNCH**

TUESDAY AFTERNOON

SESSION 2: INTERACTIVE POSTER SESSION, VENDOR EXHIBITS, WINE & CHEESE TASTING

1400-1630 **INTERACTIVE POSTER SESSION** **Ballroom, Herrmann Hall**

1400-1900 **VENDOR EXHIBITS** **Ballroom, Herrmann Hall**

1500-1700 **WINE AND CHEESE TASTING** **Ballroom, Herrmann Hall**

INTERACTIVE POSTER SESSION **Ballroom, Herrmann Hall**
Chair: Timothy Holzheimer

"Straightforward and Accurate Non-Linear Device Model Parameter Estimation Method Based on Vectorial Large-Signal Measurements" D. Schreurs, A. Beyer, B. Neuhaus, & B. Nauwelaers

"Some Observations on the Simulation of Periodic Structures", B. Neuhaus, D. Schreurs, P. Waldow, & A. Beyer

"Relative Accuracy of the Locally-corrected Nyström Method and the Method of Moments", A.F. Peterson

"Resonant Frequency and Q-Factor of Axisymmetric Composite Microwave Cavities", A.A. Kishk, D. Kajfez, & S. Chebolu

"Dielectric Properties of Biological Tissues Based on Multi-Term Debye Expression", A.Z. Elsherbeni & M.A. Eleiwa

"Fine Resolution Calculations of Energy Absorption in the Human Voxel Model, NORMAN", P.J. Dimbylow

"Effects of Antenna Separation on Antenna Factors and Gain Measurements", V. Rodriguez-Pereyra

TUESDAY EVENING: BOARD OF DIRECTORS DINNER

WEDNESDAY MORNING 21 MARCH 2001

0715 – 0800 **CONTINENTAL BREAKFAST** **Glasgow Courtyard**

0815 **PLENARY SPEAKER Prof. John Volakis**, University of Michigan **102 Glasgow Hall**
"Fast Hybrid Methods and Their Application to EM Design"

SESSION 3: TIME DOMAIN INTEGRAL EQUATIONS **(Parallel with Sessions 4, 5 & 6)** **GL 102**
Chairs: Shanker Balasubramaniam

0920 "A Fast Time-Domain Finite Element-Boundary Integral Method for 3-D Scattering", D. Jiao, A.A. Ergin, S. Balasubramaniam E. Michielssen, and J-M. Jin

0940 "Transient Finite-Elements for Computational Electromagnetics: Hybridization with Finite Differences, Modeling Thin Wires and Thin Slots and Parallel Processing", D.J. Riley

1000 "2D-FDTD Point Value Multiresolution Analysis for Maxwell's Equations", G. Antonini & A. Orlandi

1020 **BREAK**

1040 "Stable Solution of the Retarded Potential Equations", T. Abboud, J-C Nédélec, & J. Volakis

1100 "Optimization of Resistively-Loaded Wire Antennas in the Time Domain Using GA", M. Fernández Pantoja, A. Monorchio, A. Rubio Bretones R. Gómez Martín

1120 "FFT-based Acceleration of Marching-on-in time Methods (FFT-MOT), A.E. Yilmaz, D.S. Weile, J-M. Jin, & E. Michielssen

1140 **LUNCH**

WEDNESDAY MORNING 21 MARCH 2001

SESSION 4: COMPUTATIONAL BIOELECTROMAGNETICS (Parallel with Sessions 3, 5 & 6) IN 122

Chairs: Maria Stuchly

0920 "A Method of Creating Whole Body FEM Models of Humans Which Are Adjustable to Different Postures", A. Nott

0940 "Integral Equation and Finite Difference Hybrid Method for Low Frequency Electric Induction", T.W. Dawson S. Velamparambil, M.A. Stuchly

1020 **BREAK**

SESSION 5: FAST METHODS (Parallel with Sessions 3 & 6) IN 122

Chair: Donald Pflug

1040 "Efficient Computation of Potential Distribution in Layered Media using an Optimized Complex Image Prediction Model", R.M. Shubair

1100 "Analytic Preconditioner for the EFIE", H.F. Contopanagos, J.J. Ottusch, V. Rokhlin, J.L. Visher, & S.M. Wandzura

1120 "Volume Integral Equation Formulation for Scattering Using Conformal Finite Elements", K. Sertel & J.L. Volakis

1140 "Fast Inhomogeneous Plane Wave Algorithm for Three Dimensional Buried Object Problems", B. Hu & W.C. Chew

1200 **LUNCH**

SESSION 6: MOMENT METHODS (Parallel with Sessions 3, 4 & 5) ME Aud

Chairs: Kueichien Hill and Donald Pflug

0920 "Development and Application of Adaptive Basis Functions to Generate a Diagonal Moment Matrix for Electromagnetic Problems", M.L. Waller & S.M. Rao

0940 "Computation of Scattering from Bodies of Revolution Using an Entire Domain Basis Implementation of the Moment Method" A.P. Ford & P.J. Collins

1000 "An Efficient Parallel MoM to Analyze Microstrip Structures", F. Cabrera, C.N. Ojeda-Guerra, E. Jiménez, J.G. Cuevas del Río E.M. Macias-López, & A. Suárez

1020 **BREAK**

1040 "A Fringe Dual-Surface Magnetic Field Integral Equation for Three-Dimensional Structures with Nearby Sources" E. Jørgensen, P. Meincke, & O. Breinbjerg

1100 "GMRES Iterative Solution of MFIE for Simple Scattering Geometries", S. Makarov & R. Vendantham

1120 **LUNCH**

WEDNESDAY AFTERNOON

SESSION 7: CAD BY WIPL-D CODE (Parallel with Sessions 8, 9, & 10) ME Aud

Chairs: John Asvestas and Branko Kolundzija

1320 "Analysis of Composite Metallic and Dielectric Structures WIPL-D Code", B. Kolundzija, J. Ognjanovic, T. Sarkar

1340 "Differential GPS Ground Reference Antenna for Aircraft Precision Approach Operations – WIPL Design", A.R. Lopez

1400 "Commercial Antenna Designs Using WIPL-D Code", J.M. Seavey

1420 "Comparison of Results for the NEC4, WIPL-D, and EIGER Antenna Modeling Programs", M. Stamm & J.K. Breakall

1500 **BREAK**

1520 "WIPL-D Compared With Theory and Experiment", C.A. Fernandes, C. Salema, & M. Silveirinha

1540 "Design and Analysis of Selected Antennas Using WIPL-D", R.H. Johnston & M. Okoniewski

1600 "Use of the WIPL-D and NEC4 Modeling Codes in the Design of a Specialized HF Antenna Feed for the 305 Meter Arecibo Radio Telescope" M.W. Jacobs & J.K. Breakall

1620 "Analysis of a Hemispherical Dielectric Resonator Antenna With Very High Permittivity (ϵ_r=169) Using WIPL-D", S-M Jang, B. Kolundzija

WEDNESDAY AFTERNOON 21 MARCH 2001

SESSION 8: FINITE ELEMENT METHODS **Parallel with Sessions 7, 9 & 10)** **GL 102**
Chairs: Jianming Jin and David Davidson

1320 "A Higher-Order Time-Domain Finite Element-Boundary Integral Method for 3-D Scattering Analysis", D. Jiao, A.A. Ergin, B. Shanker E. Michielssen, & J-M. Jin

1340 "Modeling Complex Waveguide Structures", P.R. Foster & S.M. Tun

1400 "LT/QN Vector Finite Elements for 3D Waveguide Analysis", D.B. Davidson

1420 "Hybrid Arbitrary Order Edge Based Finite Element Methods for Electromagnetic Scattering Problems" M. Ainsworth, J. Coyle, O. Hassan, P.D. Ledger, K. Morgan, & N.P. Weatherill

1440 "Efficient Implementation of the Domain-Integrated Field Relations Method for Quasi-Static Magnetic Fields" A.T. de Hoop, I.E. Lager, & G. Mur

1500 **BREAK**

1520 "Trefftz-Type Brick Finite Elements for Electromagnetics", Y. Shlepnev

1540 "Dissimilar Mesh Formulation for the Finite Element Boundary Integral Method", J. Meese & L.C. Kempel

1600 "A Block Solver for Parametric Studies with a Hybrid FE/BE Code", P. Soudais & P. Leca

1620 "Coupled Magnetoelastic FEM Formulation including Material Anisotropy and Magnetostriction Effects in Magnetostatic Problems" O.A. Mohammed, T.E. Calvert, & R. McConnell

SESSION 9: EMC FOR REAL-WORLD APPLICATIONS **(Parallel with Sessions 7 & 8)** **IN 122**
Chairs: Bruce Archambeault, Omar Ramahi, and Stanley Kubina

1320 "Effects of Frequency and Scatterer's Shape on Heat Deposition: T-Matrix Approach", R.R. Canales, L.F. Fonseca, & F.R. Zypman

1340 "HEMCUVI: A Software Package for Electromagnetic Compatibility Analysis of On-Board Radiating Systems" F. Obelleiro, J.L. Rodríguez, J.M. Taboada, J.M. Bértolo, & J. Revaldería

1400 "Improving Power/Ground Plane EMI Decoupling Performance above 400 MHz", B. Archambeault

1420 "Modeling the Characteristics of a CH-149 Helicopter Hybrid HF Antennas", S.J. Kubina, C.W. Trueman, & D. Gaudine

1440 "Simple and Efficient Full Wave Analysis of Electromagnetic Coupling in Realistic RF Multilayer PCB Layouts Using Cascaded Parallel Plate Waveguide Model", M.R. Abdul-Gaffoor, H.K. Smith, A.W. Glisson, & A.A. Kishk

1500 **BREAK**

SESSION 10: NUMERICAL TECHNIQUES **(Parallel with Sessions 7 & 8)** **IN 122**
Chairs: D.H. Werner and Stephen Schneider

1520 "Computing Static Fields in 2.5-Dimensional Configurations based on Reduced Order Modeling", R.F. Remis & P.M. van den Berg

1540 "Accelerated Ray Tracing in Illuminated and Shadowed Areas on Discretized Structures", M. Sabielny, H-D. Brüns, & H. Singer

1600 "Comparison of Measured and Predicted Aircraft Patterns", T.M. Macnamara, C.M. Carnduff, & P.R. Foster

1620 "A Problem-Centric, User Oriented Approach To Computational Electromagnetics", G.F. Paynter, W.D. Burnside, & T.H. Lee

1640 "Modeling the Physical Optics Currents in a Hybrid Moment-Method-Physical-Optics Code" J.M. Taboada, F. Obelleiro, J.L. Rodríguez, & J.O. Rubiños

WEDNESDAY EVENING

1830 **NO HOST BAR** **La Novia Terrace**

1930 **AWARDS BANQUET** **La Novia Room**

THURSDAY MORNING 22 MARCH 2001

0715 – 0800 **CONTINENTAL BREAKFAST** **Glasgow Courtyard**

0815 **PLENARY SPEAKER: Dr. Stephen Schneider and Dr. Kueichien Hill, AF Research Academy** **Glasgow 102**
"Validation with Measurements and CEM Requirements for Aerospace Applications"

SESSION 11: WAVELET AND TLM MODELING TECHNIQUES **(Parallel with Sessions 12, 13 & 14)** **GL 102**
Chairs: Manos Tentzeris and Zachi Baharav

0920 "Solution of Large Dense Complex Matrix Equations Using a Fast Fourier Transform (FFT) Based Wavelet-Like Methodology"
K. Kim & T. Sarkar

0940 "Direct Y-Parameters Estimation of Microwave Structures Using TLM Simulation and Prony's Method"
V. Chtchekatourov, F. Coccetti, & P. Russer

1000 "Design of a Planar Antenna for Millimetre-Wave Emitter Using TLM", K.P. Heppenheimer, L. Vietzorreck, & P. Russer

1020 **BREAK**

1040 "Acceleration Techniques for Time Domain TLM Algorithms", P.P.M. So & W.J.R. Hoefer

1100 "Application of Biorthogonal Interpolating Wavelets to Time-Domain Electromagnetic Filed Simulation", M. Fujii & W.J.R. Hoefer

1120 "Efficient Wavelet-Packet Transforms by Sorting Moment Method Matrices", J. von Hagen & W. Wiesbeck

1140 "Hybrid Modeling of Thermal Behavior of Metallic and Dielectric Objects Exposed to Waveguide Cavity Fields"
W. Liu, P.P.M. So, & W.J.R. Hoefer

1200 **LUNCH**

SESSION 12: APPLICATION OF FD-TD **(Parallel with Sessions 11, 13 & 14)** **IN 122**
Chair: Wenhua Yu and Michiko Kuroda

0920 "Numerical Investigation of the Performance of Unconditionally Stable ADI-FDTD Algorithm", E. Hu, P.P.M. So, M. Fujii, W.J.R. Hoefer

0940 "FDTD Studies of Waveguides in Photonic Crystal Slabs", M.M. Siglas, L. Mirkarimi A. Grot, E. Chow, C. Flory, & V. Wilson

1000 "An Application of Body Fitted Grid Generation Method with Moving Boundaries to Solve the Electromagnetic Field in a Moving Boundary"
M. Kuroda & S. Kuroda

1020 **BREAK**

1040 "A Novel Dispersive FDTD Method for Modeling Chiral Media", A. Akyurtlu & D.H. Werner

1100 **LUNCH**

SESSION 13: OPTIMIZATION **(Parallel with Sessions 11 & 12)** **ME Aud**
Chairs: Dan Weile and Randy Haupt

0920 "Optimizing the Backscattering from Arrays of Perfectly Conducting Strips", R. Haupt & T.C. Chung

0940 "A Global Optimization Technique in the Synthesis of Reflector Antennas", O.M. Bucci, A. Capossoli, & G. D'Elia

1000 "Visual Confirmation Method of Convergence Using Improved Objective Function for GA-ICT Applied to Sector Antenna Downsizing Optimization", T. Maruyama & T. Hori

1020 **BREAK**

SESSION 14: ANTENNA ARRAYS **(Parallel with Sessions 11 & 12)** **ME Aud**
Chair: Ross Speciale

1040 "Renormalization of the Scattering Matrix", R.A. Speciale

1100 "Suppression of Reflection and Cross-talk", R.A. Speciale

1120 "Pattern Synthesis of Onboard Array Antenna Using a Method of Moments Based Formulation"
F. Obelleiro, L. Landesa, J.M. Taboada, & J.L. Rodriguez

1140 "Optimization of Thinned Aperiodic Linear Phased Arrays Using Genetic Algorithms to Reduce Grating Lobes During Scanning"
M.G. Bray, D.H. Werner, D.W. Boeringer, & D.W. Machuga

1200 **LUNCH**

THURSDAY AFTERNOON 22 MARCH 2001

SESSION 15: H-INFINITY FOR ANTENNAS **(Parallel with Sessions 16 & 17)** **IN 122**
Chairs: W. Stachnik and R. Malek-Madani

1320 "To Be Announced"

1340 "To Be Announced"

1400 "Optimal Impedance Matching by Lossless 2-Ports of Specified Degree Independent of Circuit Topology", J.C. Allen & D.F. Schwartz

1420 "Computing Performance Bounds for Wideband Impedance Matching", D.F. Schwartz & J.C. Allen

1440 "Design of Dual-Band Microstrip Antennas Using the Genetic Algorithm", H. Choo & H. Ling

1500 **BREAK**

1520 "Simultaneous Extrapolation in Time and Frequency Domains of Responses from Electromagnetic Systems", T.K. Sarkar

1540 "Fast Analysis of Microstrip Antennas and Arrays", J-M. Jin, F. Ling, & D. Jiao

1600 "H^{∞} Broadband Antenna Matching: Case Studies", J.C. Allen, L. Koyama, & D.F. Schwartz

SESSION 16: TIME DOMAIN METHODS **(Parallel with Sessions 15 & 17)** **GL 102**
Chair: Joseph Shang

1320 "Time-Domain Finite-Element Beam Propagation Method with Perfectly Matched Layer Boundary Conditions for Photonic Crystal Waveguide Simulations", M. Koshiba

1340 "Test of Nonstandard Finite Difference Time Domain Technique: Near Fields for Three-Dimensional Mie Scattering" M. I. Haftel, & J.B. Cole

1400 "Extension of Large Scale FVTD Code for Treatment of Antenna Radiation", M.D. White

1420 "A Finite-Volume, Time-Domain CEM Code for Unstructured Grids on Massively Parallel Computers", J.A. Camberos

1440 "Convergence, Stability and Dispersion Analysis of Higher Order Leap-Frog Schemes for Maxwell's Equations" H. Spachmann, R. Schuhmann, & T. Weiland

1500 **BREAK**

1520 "Compact-Difference Based Schemes for Time-Domain Computational Electromagnetics", J.S. Shang

1540 "A Distributed Implementation of the Finite-Difference Time Domain (FDTD) Method", T. Baehr-Jones, M. Hochberg, & A. Scherer

SESSION 17: NEC MODELING **(Parallel with Sessions 15 & 16)** **ME Aud**
Chair: Keith Lysiak

1320 "Automatic Wire-Grid Modeling of Complex Bodies to be Analyzed with NEC", J.M. Taboada, J.L. Rodríguez, & F. Obelleiro

1340 "The Effects of Rotor Modulation on a Sikorsky HH-60J Helicopter HF Communication Antenna", T. Firestone, K.J. Cybert D.D. Reuster, & M.E. McKaughan

1400 "USCG Aircraft – HF Antenna Study", K.J. Cybert, D.D. Reuster, R.B. Mead, & M.E. McKaughan

1420 "Numerical Modeling of an AS-145 Direction Finding Antenna", K. Lysiak & J. Signorotti

1440 **BREAK**

FRIDAY MORNING 23 MARCH 2001

0700 – 0730	**CONTINENTAL BREAKFAST** (For Short Course and workshop attendees only)	**GLASGOW COURTYARD**
0730 – 0820	**SHORT COURSE/HANDS-ON-WORKSHOP REGISTRATION**	**GLASGOW 103**
0830 – 1130	**WORKSHOP #6 (HALF-DAY, MORNING) - "Basic Antenna Modeling Using NEC2 ('The ABC's of NEC')"** Mike Jacobs, PSU, for L. B. Cebik, (assisted by J. Breakall, PSU, J. Burke, LLNL, and R. Adler, NPS)	**RO 204**
1330 – 1630	**WORKSHOP #7 (HALF-DAY, AFTERNOON)** **"Advanced Antenna Modeling Using NEC-WIN PRO and GNEC: ('The Rest of the NEC Alphabet')"** J. Breakall and J. Burke (assisted by M. Jacobs and R. Adler)	**RO 204**
0830 – 1130	**SHORT COURSES #8 (HALF-DAY, MORNING) - "Frequency Selective Structures and Their Characterization Using Hybrid Finite Element Methods"**, J. Volakis, Y. Erdemili, H. Syed, U of Mich. R.Gilbert, BAE Syst.	**GL 102**
0830 - 1130	**SHORT COURSES #9 (HALF-DAY, MORNING) - "Overview of Numerical Computational Methods in Electromagnetics"**, J. Karty, The Boeing Co.	**IN 122**
0830 – 1130	**SHORT COURSES #10 (HALF-DAY, MORNING) - "Wavelets in Electromagnetics"** N. Ida, U of Akron, (with M. Raugi and S. Barmada)	**ME Aud**

ACES 2001 SHORT COURSES / WORKSHOPS

March 19 and 23

Schedule and Abstracts

Monday, 19 March 2001

0830 – 1630 **SHORT COURSE #1** (Full Day)

"Computational Electromagnetic Methods in Mobile Wireless Communication Design", Ray Perez, Jet Propulsion Laboratory

The basis of this course is to illustrate the different computational electromagnetic methods that can be used in designing and analyzing mobile wireless communication hardware and problems respectively. The objective of this course is threefold: a) provide students with the most salient research topics in the constantly evolving field of mobile wireless communications, b) to equip prospective students with a knowledge of what types of mobile wireless design are feasible to address using electromagnetic computational techniques, c) provide detail examples on the usage of electromagnetic computational methods (CEM) in the design of wireless communications components.

Major Topics.

1. Brief Review of the strengths and deficiencies of CEM techniques such as MOM, FDTD, FEM, and GTD/UTD in addressing different types of problems.
2. The use of CEM in addressing interference in wireless mobile systems.
3. The use of CEM in smart antennas design (base stations, mobile, PCS, bluetooth, and satellite antennas)
4. Design techniques for RF components assisted with CEM methodologies
5. Design techniques for Digital components assisted with CEM methodologies
6. The role of CEM in propagation models
7. Bioelectromagnetics
8. System level designs and CEM.
9. Present Business Opportunities

0830 – 1630 **SHORT COURSE #2** (Full Day)

"The Finite Difference Time Domain Technique for Electromagnetic Applications", Atef Z. Elsherbeni and Allen W. Glisson, University of Mississippi

This course will provide an overview of the finite difference time domain technique (FDTD) as applied to antennas and microwave devices. The first half of the course will be dedicated to the basic theories for developing a working algorithm. Among the topics to be covered are: Maxwell's equations in Cartesian coordinates, difference approximations, Yee algorithm, total vs. scattered field formulation, numerical stability, numerical dispersion, plane wave representation, types of sources, types of waveforms, absorbing boundary conditions, thin wire approximation, near to far field transformation, dispersive media, and modeling of lumped elements. The second half of the course will be dedicated to presenting examples of how to apply the FDTD technique for analyzing antennas, cross talk in digital circuits, and biological effects of handheld communication antennas. The attendee will receive 1D, 2D, and 3D educational codes with graphical user interfaces.

Monday, 19 March 2001

0830 – 1630 **SHORT COURSE #3** (Full Day)

"EMI/EMC Computational Modeling for Real-World Engineering Problems", Omar M. Ramahi, University of Maryland and Bruce Archambeault, IBM

The world of EMI/EMC compliance has become more important than ever before due to several technological advances such as high-speed processors and low cost packaging. The 'old ways' of using design rules and then fixing the EMI problems after the product is built, are not acceptable in today's highly competitive development environment. Designs must be cost effective, and must pass regulatory requirements the first time through the design cycle. All this makes modern electromagnetic analysis tools highly indispensable to EMI/EMC engineers.

There are several electromagnetic tools available to EMI/EMC engineers. These tools, which are based on the FDTD method, the MoM, or the Finite Elements method (or even other techniques) allow a better and more accurate estimation of the EMI/EMC effects of a system before it is built. These tools were conceived and developed, for the most part, by electromagnetic engineers working in the areas of radar cross section studies and scattering. Adapting these tools to solve real-world EMI/EMC engineering design problems takes a different perspective. For instance, modeling aspects that were irrelevant in other areas, such as the essence of radiating sources, become highly crucial in EMI/EMC studies.

In this course, we present a summary of the most popular numerical modeling techniques. However, we depart from the classical, and mostly academic, presentations and emphasize the modeling aspects that have direct relevance on practical and meaningful modeling. The discussion will be focused on how to use the available tools to obtain meaningful results rather than on how to develop or advance the tools.

EMI/EMC analyses typically involve a very wide band of frequency. This creates the immense challenge of developing numerical models that remain reasonably accurate over a relatively wide frequency band. These challenges will be discussed and practical remedies will be suggested.

Several detailed examples will be presented showing how to create real-world models. Radiated emissions, radiated susceptibility and ESD are all discussed and demonstrated with *real-world* problems. We conclude this course with a discussion of model validation techniques and present standard modeling problems that allow engineers to evaluate commercial software packages.

0830 – 1630 **SHORT COURSE #4** (Full Day)

"Scripting Electromagnetics Simulators in PYTHON", Eric Jones, Duke University

PYTHON is an open source, platform independent scripting language that has a wealth of general-purpose libraries. It is elegant, easy to use, and possesses numeric features similar to those of MATLAB. These traits, along with its ability to "wrap" legacy FORTRAN and C routines, make PYTHON perfect as an electromagnetic simulation environment. The first half of this tutorial will cover the PYTHON language and several libraries highlighting its numeric, plotting, and 3D visualization capabilities. The second half will introduce a new open source MoM code for dielectric and PEC targets in a half-space media from Duke University. Interfaces to NEC and an advanced MLFMA code are also discussed. Examples illustrating genetic antenna design and web integration are presented.

Morning:

1. Demo of EM codes and their PYTHON interface -
2. Installation help for those who wish
3. Introduction to interpreter environment
4. Basic PYTHON data types
5. PYTHON Control Structures
6. Built-in Libraries
7. Plotting and Visualization
8. Wrapping C/FORTRAN code

Afternoon

1. Introduction to NEC interface
2. Halfspace MoM/MLFMA interface
3. GA optimization of Antennas in PYTHON

Monday, 19 March 2001

0830 – 1630 **SHORT COURSE #5** (Full Day)

"Electromagnetic Visualization" John Shaeffer, Marietta Scientific

Visualization in electromagnetics is required if we are to truly understand the specific physics which govern our designs and thus enable us to optimize system performance. Just because we can solve Maxwell does not mean that we understand Maxwell. Typically we just compute an antenna or scattering plot for comparison to measurement. This is unfortunate because within our computational models is a treasure trove of physical information that can significantly help our physical understanding.

This course will focus on frequency domain visualization applications with OpenGL graphical approaches for geometries, currents, near fields, and far field patterns.

The afternoon session will focus on Bistatic k-Space Imaging for the frequency domain which enables us to compute radiation / scattering centers without doing a frequency sweep. This provides a significant amount of diagnostic / physical information without having to re-compute a solution over a bandwidth of frequencies (which for most MOM code applications would become prohibitive).

Friday, 23 March 2001

0830 – 1130 **WORK SHOP - 1 #6** (Half Day – Morning)

"Basic Antenna Modeling Using NEC2 ('The ABC's of NEC')", Mike W. Jacobs (for L. B. Cebik) assisted by Jim Breakall, Jerry Burke and Richard Adler

The mastery of NEC-2, the most-used method-of-moments antenna modeling code, begins with a command of modeling language and familiarity with the elements of a "thin-wire" model. Students will learn how to develop antenna models by instruction and hands-on experience, using their workstations. Topics include: creating antenna geometry; segmenting wire models; placing sources loads and transmission lines; selecting proper ground systems; specifying azimuth and elevation pattern plots, frequency sweeps; determining source impedance and VSWR; testing antenna models via convergence and average gain tests and using the extensive tabular data produced by NEC-2. Using NEC-Win Plus to design antennas via the use of equations completes the list of topics. Students will have an opportunity to purchase NEC-Win Plus, NEC-Win Pro or GNEC at reduced prices.

1330 – 1630 **WORK SHOP - 2 #7** (Half Day - Afternoon)

"Advanced Antenna Modeling Using NEC-WIN PRO and GNEC - ('The Rest of the NEC Alphabet')", Jim Breakall and Jerry Burke assisted by M. Jacobs and Richard Adler.

This workshop introduces the full set of features in NEC2 and in NEC4. It follows the BASIC ANTENNA MODELING USING NEC2 workshop and is intended for users who need to fully exploit the Windows-based graphical user interface (GUI) shells of NEC-Win Pro and GNEC. Students will be guided through this family of codes using a hands-on approach that employs many example problems. They will also be given additional antenna modeling projects to complete on their own and in team settings. Students will have the opportunity to interact with instructors in one-on-one situations, and are encouraged to bring their own problems to present to the instructors and the class. Attendees may purchase NEC-Win Plus, NEC-Win Pro or GNEC at reduced prices.

Friday, 23 March 2001

0830 – 1130 **SHORT COURSE #8** (Half Day)

"Frequency Selective Structures and Their Characterization Using Hybrid Finite Elements Methods"
J. L. Volakis*, R. Gilbert++, Y. Erdemli*, H. Syed*, *University of Michigan, ++BAE Systems

Frequency selective surfaces (FSS) are periodic structures widely used as filters for antenna radomes, either in planar or non-planar form. FSS have also been used to construct artificial substrates to enhance antenna performance. More recently, frequency selective volumes as is the case with Periodic Bandgap (PBG) structures have gained interest for various antenna and microwave applications.

This half-day short will focus on the characteristics, properties and analysis of frequency selective structures. A survey of the various FSS elements will be presented and their characteristics will be discussed. We will also cover equivalent circuits, multilayer configurations and applications of frequency selective surfaces (as superstrates and substrates) to enhance antenna performance. The analysis of periodic structures requires adaptable and robust computational tools such as the hybrid finite element method. We will present the basics of this approach for periodic structures and antenna array characterizations (formulations and modeling approaches). In addition, w
e will present optimization approaches in connection with fast O(N) hybrid finite element algorithms for design purposes.

0830 – 1130 **SHORT COURSE #9** (Half Day)

"Overview of Numerical Computational Methods in Electromagnetics ", Janice Karty, The Boeing Company

There are several Computational Electromagnetics (CEM) tools available to the Radar Cross Section (RCS) engineer for the evaluation and reduction of target signatures. This summary course of popular numerical modeling techniques is designed for both the beginning and intermediate audience. Emphasis will be on fundamental concepts and physical mechanisms. The objective of this course is twofold: to summarize methods applicable to RCS analysis and design, and to provide guidelines for use of the various CEM techniques. It is expected that after taking this course, participants will be better able to identify appropriate algorithms and codes for meaningful analysis of air, land and sea vehicles. Several examples will be discussed for real world models, including applications to both scattering and radiation. Among the topics to be covered are: physical optics, edge diffraction, method of moments, finite element methods, hybrid techniques, and model preparation/gridding issues.

Friday, 23 March 2001

0830 – 1130 **SHORT COURSE #10** (Half Day)

"Wavelets in Electromagnetics", Nathan Ida, University of Akron, with Marco Raugi, Sami Barmada

Part I Theory background

- Introduction to the basic theory of wavelets
- The Continuous Wavelet Transform
- The concept of multiresolution
- Wavelet analysis – emphasis on the discrete time approach.
- Algorithmic aspects of the discrete time wavelet transform
  - Mallat algorithm
  - Implementation with filter banks
  - Design issues.
- Some applications of wavelets
  - compression
  - de-noising
  - numerical solution of PDEs

By giving special attention to the properties that one can expect from wavelet methods, their advantages and limitations in diverse fields of application will be shown. This should enable the participants to develop a practical understanding and know-how of the wavelet techniques.

Part II Applications

- Application of the wavelet transform to computational electromagnetics.

Multiresolution techniques based on wavelets have demonstrated their capability to reduce computation time and computer memory requirements in the modelling of electromagnetic structures; the use of wavelets also provides a natural approach to adaptive refinement of the computational domain in those regions of space where the electromagnetic fields and their derivatives require improved accuracy.

The purpose of this part of the tutorial is to provide insight into the wavelet framework and to show how it can be an efficient tool for numerical modeling.

In particular, wavelet based techniques will be discussed for the solution of electromagnetics problems formulated by both differential and integral equation, pointing out the advantages and drawbacks they provide, in contrast to the more traditional numerical methods.

CONFERENCE - SHORT COURSES - WORKSHOPS REGISTRATION

17TH ANNUAL REVIEW OF PROGRESS IN APPLIED COMPUTATIONAL ELECTROMAGNETICS

March 19-23, 2001 - Naval Postgraduate School, Monterey, CA

I. CONFERENCE PRE-REGISTRATION FORM

Please print (Black ink) (NOTE: CONFERENCE REGISTRATION FEE DOES NOT INCLUDE ACES MEMBERSHIP FEE OR SHORT COURSE FEE)

Last Name First Name Middle Initial

Company/Organization/University Department - Mail Station

Mailing Address: Street Address - P.O. Box # - Apartment #. etc.

City Province/State Country Zip/Postal Code

Telephone Fax E-mail Amateur Radio Call Sign

	BY 3/1/01	3/2/01 - 3/13/01	3/14-3/23/01
ACES MEMBER	☐ $310	☐ $325	☐ $340
NON-MEMBER	☐ $365	☐ $380	☐ $395
STUDENT/RETIRED/UNEMPLOYED	☐ $130 (no proceedings)	☐ $130	☐ $130
STUDENT/RETIRED/UNEMPLOYED	☐ $165 (includes proceedings)	☐ $165	☐ $165
BANQUET ☐ Meat ☐ Fish	☐ $ 35	☐ $ 35	☐ $ 35

Total for Section I - __________

II. ACES '2001 SHORT COURSES AND HANDS-on-WORKSHOPS REGISTRATION

		by 3/1	3/2-3/13	3/14-3/23
1.	Computational Electromagnetic Methods in Mobile Wireless Communications Design (full-day) Monday, March 19, R. Perez	☐ $160	☐ $175	☐ $190
2.	The Finite Difference Time Domain Technique for Electromagnetic Applications (full-day) Monday, March 19, A.Z. Elsherbeni and A.W. Glisson	☐ $160	☐ $175	☐ $190
3.	EMI/EMC Computational Modeling for Real-World Engineering Problems (full-day) Monday March 19 O.M. Ramahi and B. Archambeault	☐ $160	☐ $175	☐ $190
4.	Scripting Electromagnetics Simulators in PYTHON (full-day) Monday, March 19, E. Jones	☐ $160	☐ $175	☐ $190
5.	Electromagnetic Visualization, (full-day) Monday March 19, J. Shaeffer	☐ $160	☐ $175	☐ $190

II. ACES 2001 SHORT COURSES AND HANDS-on-WORKSHOPS REGISTRATION (cont)

6.	Basic Antenna Modeling Using NEC2 (The ABC's of NEC) **Workshop** (half-day - Friday morning), March 23, Mike Jacobs, (for L.B. Cebik) assisted by J. Breakall, J. Burke, and R.W. Adler	☐ $120	☐ $135	☐ $150
7.	Advanced Antenna Modeling Using NEC-WIN PRO and GNEC (The Rest of the NEC Alphabet) **Workshop ,** (half-day - Friday afternoon) March 23 J. Breakall, J. Burke, assisted by Mike Jacobs and R.W. Adler	☐ $120	☐ $135	☐ $150
8.	Frequency Selective Structures and their Characterization Using Hybrid Finite Elements Methods, (half-day - Friday morning) March 23 J.L. Volakis, R. Gilbert, Y. Erdemli, H. Syed	☐ $100	☐ $115	☐ $130
9.	Overview of Numerical Computational Methods in Electromagnetics, (half-day-Friday morning) March 23 J. Karty,	☐ $100	☐ $115	☐ $130
10.	Wavelets in Electromagnetics - (half-day-Friday morning) March 23 N. Ida and M. Raugi	☐ $100	☐ $115	☐ $130

Total for Section II-____________

TOTAL PAYMENT

Include all Applicable Fees Here

Section I ____________

Section II ____________

Total Remittance Submitted (U.S. Dollars Only): ____________

Non-USA participants: Prices are in U.S. dollars. All currencies must be converted to U.S. dollars payable by banks with U.S. affiliates. (1) **Bank Checks**, if (a) drawn on a U.S. Bank, (b) Have U.S. Bank address, (c) contain series of (9) digit mandatory routing numbers: (2) **Traveler's Checks** (in U.S. $$): (3) **International Money Order** drawn in U.S. funds, payable in U.S.: (4) **Credit Cards:** Visa, MasterCard, Discover and AmEx. **Send Payment to**: Richard W. Adler, Code EC/AB, Naval Postgraduate School, 833 Dyer Road, Room 437, Monterey, CA 93943-5121.

PAYMENT SHOULD ONLY BE MADE PAYABLE TO: "ACES"
Method of payment

☐ Bank Check for the total amount (payable to ACES).
☐ Traveler's Check for total amount (payable to ACES)
☐ International Money Order for total amount (payable to ACES)
☐ Credit Card: ☐ MasterCard ☐ Visa ☐ Discover ☐ AMEX

Credit Card Number ____________________

Expiration Month ____ Year ____

Print name Sign name

Address

City/State/Country/Zip/Postal Code

MOTELS / HOTEL LIST FOR MARCH 2001 ACES SYMPOSIUM

19-23 MARCH 2001

**** (WITHIN WALKING DISTANCE OF NPS)**

FIRESIDE LODGE (**) (1 star)
1131 10th St. Monterey, CA 93940
Phone: (831) 373-4172 FAX: (831) 655-5640
Rates: **Govt**. $89.---**Conf**. $89 + tax

STAGECOACH MOTEL (**) (1 Star)
1111 10th St. Monterey, CA 93940
Phone: (831) 373-3632 FAX: (831)-648-1734
Rates: **Govt**. $74.---**Conf**. $79 + tax

MONTEREY BAY LODGE (**) (2 Star)
55 Camino Aguajito, Monterey, CA 93940
Phone: (831) 372-8057 FAX:(831) 655-2933
Rates: **Govt**. and Conf. $44.10 + tax

MONTEREY HILTON (**) (3 Star)
1000 Aguajito Rd. Monterey, CA 93940
(831) 373-6141 FAX: (831)375-2367
Rates: **Conf**.$139. + tax (no govt. rates)

HYATT HOTEL & RESORT (**) (4 Star)
1 Old Golf Course Rd. Monterey, CA 93940
Phone: (831) 372-1234 FAX: (831)-375-6985
Rates: **Govt**. $75.- 146; **Conf**. $159 + tax

Most motel/hotel rates apply to Monday through Thursday!

(1) MOTELS **WEEKEND RATES MAY BE HIGHER** THAN WEEKDAYS. (2) **MENTION THAT YOU ARE ATTENDING THE "ACES" CONFERENCE** AT NPS WHEN BOOKING (3) CUT OFF DATE FOR CONFERENCE RATES IS USUALLY ONE MONTH PRIOR TO START OF CONFERENCE. (CHECK WITH THE HOTEL IF YOU NEED SPECIAL ARRANGEMENTS) (4) **ATTENDEES** ON **GOVT ORDERS DO NOT PAY TAX**. ATTENDEES PAYING CONF. RATE, PAY TAX. (5) **PRICES GIVEN ARE FOR ONE PERSON, ONE BED**.

IMPORTANT INFORMATION FOR ACES ATTENDEES, PLEASE READ.

Hotel room tax exemption requires all of the following documents: (1) Travel Orders, (2) Payment by government issued AMEX/VISA card; (3) Govt./Military identification. Regarding Govt orders: prevailing perdiem lodging rate at time of arrival will be honored. Attendees on Govt. orders do NOT pay city tax; every other attendee pays city tax!

When you book a room, mention that you are attending the "**ACES**" Conference, at NPS, and ask for either Government, or Conference rates.

There is NO Conference PARKING at the Naval Postgraduate School or on nearby streets, so we advise you to book a room within walking distance, or plan to use a taxi.

Third Street Gate is the closest "open" gate to the Conference Registration location . The Ninth Street gate is always open.

AIRLINE INFORMATION

The following airlines make connections from Los Angeles and San Francisco, CA. to Monterey: United. Express, and American Eagle, both fly a 30-34 passenger, Prop Jet airplanes. American Eagle, serves Los Angeles to Monterey, but not San Francisco to Monterey. There is no airline connection directly from San Jose, CA to Monterey, CA.

FLYING FROM SAN JOSE OR SAN FRANCISCO? MONTEREY/SALINAS AIRBUS

Departs every two hours from San Francisco for San Jose Airport, Salinas, and Monterey. Rate is $30.00 per person, one way. Reservations recommended. Cash/credit cards accepted. Departs SFO 7, 9, 11 AM; 1, 3, 5, 7, 9, and 11:15 PM. For more information, phone 831-883-2871. www.montereyairbus.com

THINGS TO DO AND SEE IN THE MONTEREY BAY AREA

There are many activities for children and adults not attending the Conference. The colorful blue Monterey Bay is a vision of historic Monterey, rich with natural beauty and many attractions from Fisherman's Wharf, (be sure to try the seafood cocktails), to Cannery Row, the Monterey Adobes and city parks, the Monterey Bay Aquarium, Maritime Museum of Monterey, and Pacific Grove Museum of Natural History. The "Artichoke Capital of the World" is only 15 miles from Monterey, in Castroville.

Other things to do include: driving the17-Mile Drive in Pebble Beach; Whale watching, bicycle riding, roller blading, surfing, ocean kyaking, in Pacific Grove; taking a stroll on the white sandy beach in Carmel, a visit to Mission San Carlos Borromeo Del Rio Carmelo, in Carmel, etc. The Monterey Peninsula has 20 Golf Courses. Carmel has many Art Galleries. Wine tasting tours might be available. For more information, call the Monterey Peninsula Chamber of Commerce, Visitors and Convention Bureau at (831) 649-1770.

APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY
RICHARD W. ADLER, EXECUTIVE OFFICER, ECE DEPARTMENT, CODE ECAB, NAVAL POSTGRADUATE SCHOOL, 833 DYER ROAD, RM 437, MONTEREY, CA 93943-5121, PHONE: 831-646-1111 FAX: 831-649-0300 EMAIL: RWA@ATTGLOBAL.NET

please print

LAST NAME ____ FIRST NAME ____ MIDDLE INITIAL ____

COMPANY/ORGANIZATION/UNIVERSITY ____ DEPARTMENT/MAIL STATION ____
(PLEASE LIST THE ADDRESS YOU WANT USED FOR PUBLICATIONS BELOW)

MAILING ADDRESS ____

CITY ____ PROVINCE/STATE ____ COUNTRY ____ ZIP/POSTAL CODE ____

TELEPHONE ____ FAX ____ AMATEUR RADIO CALL SIGN ____

E-MAIL ADDRESS ____ E-MAIL ADDRESS CAN BE INCLUDED IN ACES DATABASE YES ☐ NO ☐
PERMISSION IS GRANTED TO HAVE MY NAME PLACED ON MAILING LISTS WHICH MAY BE SOLD YES ☐ NO ☐

CURRENT SUBSCRIPTION PRICES

AREA	INDIVIDUAL SURFACE MAIL	INDIVIDUAL AIRMAIL	ORGANIZATIONAL (AIRMAIL ONLY)
U.S. & CANADA	( ) $65	( ) $65	( ) $115
MEXICO, CENTRAL & SOUTH AMERICA	( ) $68	( ) $70	( ) $115
EUROPE, FORMER USSR, TURKEY, SCANDINAVIA	( ) $68	( ) $78	( ) $115
ASIA, AFRICA, MIDDLE EAST & PACIFIC RIM	( ) $68	( ) $85	( ) $115

FULL-TIME STUDENT/RETIRED/UNEMPLOYED RATE IS $25 FOR ALL COUNTRIES

Non-USA participants: Prices are in U.S. dollars. All currencies must be converted to U.S. dollars payable by banks with U.S. affiliates. (1) Bank Checks, must have U.S. address of bank; (2) Traveler's Checks (in U.S. $$); (3) U.S./International Money Order drawn in U.S. funds, payable in U.S., (4) Credit Cards: Visa, MasterCard, Amex and Discover.

PAYMENT METHOD: ALL CHECKS/TRAVELER'S CHECKS/MONEY ORDERS ARE PAYABLE TO "ACES"

☐ CHECK (PAYABLE TO ACES) ☐ TRAVELER'S CHECKS ☐ INTERNATIONAL MONEY ORDER

☐ CREDIT CARD ☐ VISA ☐ MASTERCARD ☐ AMEX ☐ DISCOVER

CREDIT CARD USERS

SIGNATURE AND ADDRESS OF CARD HOLDER IS MANDATORY.

IF YOU ARE PAYING VIA ANOTHER PERSONS CARD, HE/SHE MUST PRINT AND SIGN NAME AND ADDRESS.

PRINT CARD HOLDER NAME: ____

CREDIT CARD HOLDER SIGNATURE: ____

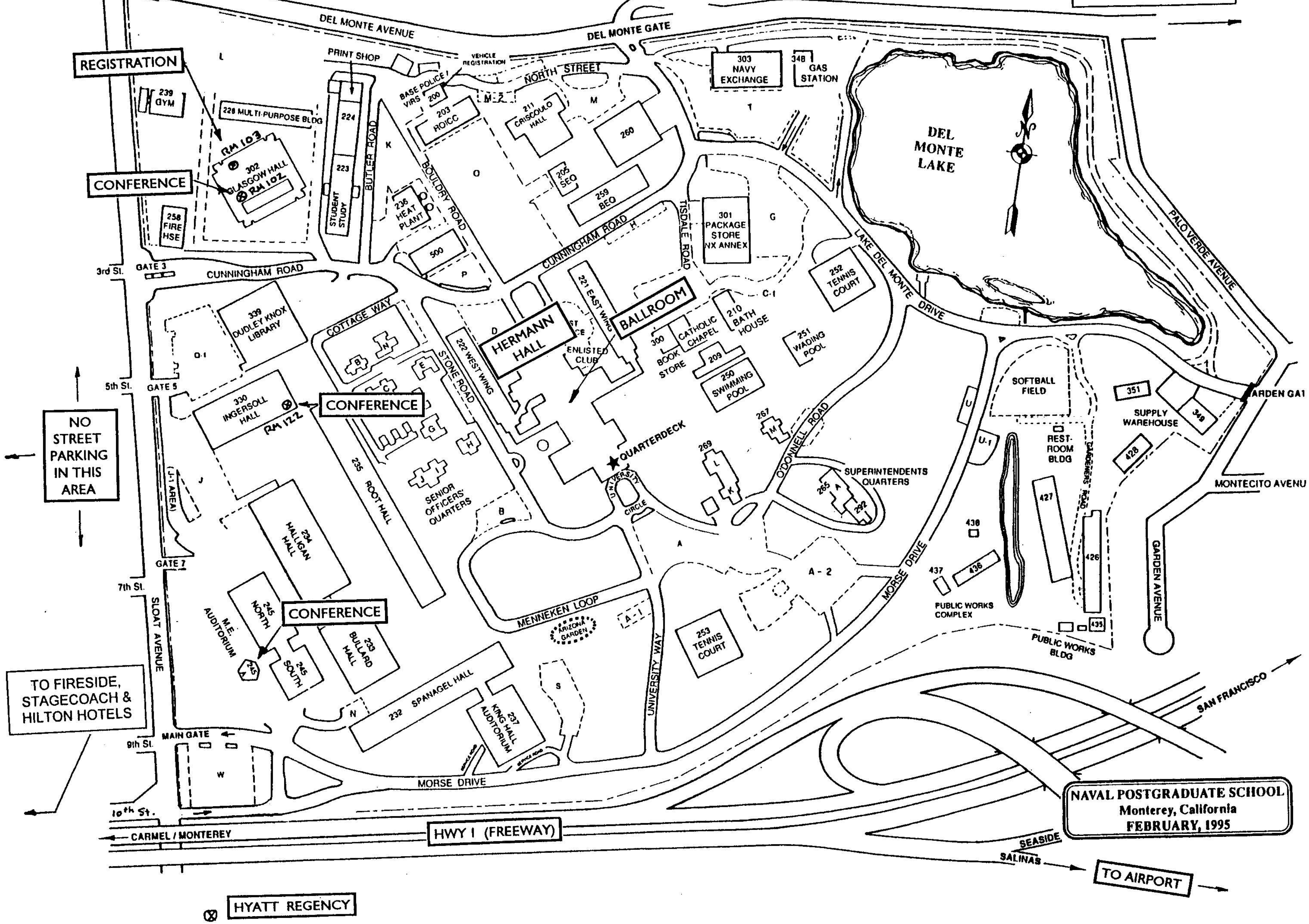
CREDIT CARD EXPIRATION DATE: ____/____

CREDIT CARD HOLDER ADDRESS: ____

CREDIT CARD ACCOUNT # ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

2001

ACES CONFERENCE



DEADLINE FOR THE SUBMISSION OF ARTICLES

Issue	Copy Deadline
March	January 13
July	May 25
November	September 25

For the ***ACES NEWSLETTER*** send copy to Ray Perez in the following formats:

1. A hardcopy.
2. Camera ready hardcopy of any figures.
3. If possible also send text on a floppy disk. We can read any version of MICROSOFT-WORD and ASCII files on both IBM and Macintosh disks. On IBM disks we can also read WORDPERFECT, WORDSTAR, and LATEX files. If any software other than MICROSOFT WORD has been used on Macintosh Disks, contact the Managing Editor, Richard W. Adler **before** submitting a diskette. If it is not possible to send a Macintosh disk then the hardcopy should be in Courier font **only**, for scanning purposes.