APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY (ACES)

NEWSLETTER

Vol. 15 No. 1 March 2000

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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.

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OFFICER'S REPORTS

PRESIDENT'S MESSAGE

It's hard to believe, but the countdown to the ACES 2000 conference is already measured in weeks, and the grand event will be on us in a heartbeat now! Guess it really is true that time flies when your day job is grinding you to a pulp. The need for dispatching this message has rudely reminded me that I have failed to finalize my travel details, and need to get with it. I hope you will be all set by the time you are reading this message but, if not, will take this as a gentle prod to spring into action and be among the happy ACES 2000 contingent in Monterey. On behalf of ACES, I would like to thank the conference staffers who have worked long and hard this year. It appears that we can look forward to truly outstanding slates of both technical program papers and short courses this year.

My sincere apologies are extended to Prof. Masanori Koshiba for my serious oversight in the last ACES Newsletter. An ACES-Japan Short Course was offered in October 1999, and the offering was highly successful with an attendance of more than 200 participants. Last time, I properly credited John Brauer for his initiation and liaison efforts, but inadvertently failed to mention Prof. Koshiba. To set the record straight, Prof. Koshiba is a valued active member of ACES, and deserves the bulk of the credit for the occurrence and success of the ACES-Japan Short Course. He did most of the work, and I would like to thank him publicly in this message for both his contributions to the short course and kind tolerance of my earlier error.

The centerpiece activity for ACES remains the annual conference. The role and priority of other activities is a matter which will be reviewed at this year's Board of Directors (BoD) meeting. Expanding educational activities is a possibility for ACES in the future, but the extent of need and the best approach remain unclear. Repeated attempts to offer short courses and workshops on the U.S. East Coast have yielded negative to mixed results. The ACES-Japan Short Course, on the other hand, was a very positive experience. During the past year, some discussion has occurred about the possibility of Web-based instruction through ACES. In short, if you have an interest and some definite opinions and/or suggestions for the BoD, your input is both welcome and invited. The time and place for the BoD meeting in Monterey will be printed in the conference agenda, and BoD meetings are open to interested ACES members. If you have a specific offering to present to the BoD, please contact me by email and we will enter your request as an agenda item.

I am thinking of scheduling an open "Town Hall" type meeting at the conference this year, but there is a complication. The Naval Postgraduate School has shifted their academic calendar on short notice, so this year we will be conducting the conference during a regular week of NPS classes, and not during the comparatively dead exam week that we usually enjoy. This means that meeting rooms will be scarce to non-available this year during regular business hours for the school. If there is sufficient demand, I will ask for a room late in the afternoon one day, so that we can have a general open discussion. Please email me with your dates of arrival and departure if you would care to participate in a "Town Hall" type meeting at the conference this year.

Submitted with best wishes for health and prosperity to good ACESians everywhere,

Perry Wheless, wwheless@coe.eng.ua.edu
ACES President

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 21 March 2000, 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 1999.
2. Announcement of the Ballot Election of the Board of Directors.

By order of the Board of Directors
Eric Michielssen, Secretary

ANNUAL REPORT 1999

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 1999, the paid-up membership totaled 377, with approximately 40% of those from non-U.S. countries. There were 30 full time students, unemployed and retired; 75 industrial (organizational); and 272 individual members. The total membership has decreased by 11% since 1 Jan 1999, with non-U.S. membership increasing by 11%.

Eric Michielssen, 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

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	42,652
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	$177,274

LIABILITIES: $0

NET WORTH 31 December 1999: $177,274

INCOME

Conference	62,407
Short Courses	26,757
Publications	1,312
Membership	34,995
Interest & misc.	6,658
TOTAL	$132,129

EXPENSE

Conference	34,380
Short Courses	10,404
Publications	8,831
Services (Legal, Taxes)	4,103
Postage	5,877
Supplies & misc.	15,990
TOTAL	$79,585
NET INCREASE FOR 1999	$52,544

In 1998 the net increase was $7,523. In 1999 we enjoyed a net gain of $52.544. This increase was due to (1) Many 1998 expiring memberships were renewed in 1999, late, and (2) Conference income doubled and (3) Short Course income doubled. Our current net worth $177,274 has increased by 30% from last year.

Andreas Cangellaris
Treasurer

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HISTORICAL	Robert Bevensee	BOMA Enterprises PO Box 812 Alamo, CA 94507-0812

COMMITTEE REPORTS

PUBLICATIONS

The message from Publications is fairly "short and sweet" this time. Atef Elsherbeni has continued to make improvements to the ACES web site, aces.ee.olemiss.edu, and many of his more recent implementations involve future applications for the ACES Journal and ACES Newsletter, as well as for the conference and conference Proceedings. Prior to the ACES 2000 conference in Monterey in March, you are urged to visit the ACES web site and familiarize yourself with some of the new contents and features. The technical program agenda is tight, but we are endeavoring to find a time slot when Atef can demo the new and evolving site features. Check the final conference agenda for a time and place when you check in at the conference registration area.

Priorities and future directions for both the Journal and Newsletter will be discussed at length during conference week this year. There are numerous significant issues on the table at this point in time, and some important decisions which must be made in the near future. For example, a deployment strategy for future electronic distribution of the Newsletter is a currently active issue. Unfortunately, because the issues are many, lengthy, and rather open-ended, and the final decisions have not been made, a more detailed and specific report to the membership is not possible here. This message is primarily to inform ACES members that Publications is aware of the need for change on many fronts, and is seeking to address those needs. Futher, readers of this report should note that there will be a Board of Directors meeting, a Publications meeting, and (probably) an open "Town Hall" type meeting at the upcoming conference, in addition to the annual meeting of members on Tuesday morning. All these events will be noted on the final conference agenda, and are available forums for you to present your concerns and/or constructive comments.

You may be interested to know that changes in the ACES Journal editorial board makeup will be considered during the spring and summer. If you have aspirations of becoming a new member of the Journal editorial board, you should know that your submission of a manuscript to the Journal will entitle you to serious and immediate consideration. You should highlight your interest in your manuscript transmittal letter, so that editors Kishk and Glisson will be alerted.

We look forward to seeing you at ACES 2000, and invite your future active involvement with ACES Publications!

REPORT OF 1999 ACES-JAPAN SHORT COURSES

These short courses were presented on 14 October 1999 at the Shin-Yokohama Prince Hotel at Kohoku-ku, Yokohama-shi, Kanagawa, 222-8533 JAPAN. Prof. Masanori Koshiba, ACES member, Hokkaido University, Sapporo, Japan, was the organizer and Chairperson for this event. Prof. Koshiba reported that he was able to welcome a total of 200 participants. The opening address was presented by Prof. Norio Takahashi, ACES Board of Directors.

Six short courses were taught by Zoltan J. Cendes, Ansoft Corporation, Pittsburgh, PA; Jovan Lebaric, Naval Postgraduate School, Monterey, California, and Richard C. Hall, Ansoft Corporation, Pittsburgh, PA.

TECHNICAL FEATURE ARTICLE

ANALYSIS AND MODELING OF WEAKLY NONLINEAR SYSTEMS

Donald D. Weiner[1]
Andrew L. Drozd, Kurt V. Sunderland & Irina Popitich[2]

ABSTRACT

This paper is the first in a series of articles which will explore the analysis and modeling of nonlinear behaviors in circuits, devices, and receiver systems. Discrete and quasi-discrete methods can be developed to readily analyze complex nonlinearities from elemental formulations such as the weakly nonlinear series. The emphasis of this paper is on the modeling and analysis of weakly nonlinear effects in electronic circuits [1]. First principles of nonlinear receiver phenomena, behavior, responses, and effects are briefly presented. The topics discussed are quite general and have application to such diverse areas as automatic control, broadcasting, cable television, communications, electromagnetic compatibility, electronic devices, instrumentation, signal processing, and systems theory.

INTRODUCTION

This paper establishes a foundation for the subsequent discussion of the various ways one can model and analyze nonlinear effects. These methods make use of measured quantities such as the 1-dB compression point, 3rd-order intermodulation coefficient, 3rd-order intercept point, and two-signal spurious-free dynamic range parameters. Some of these quantities or parameters can be readily determined through measurement whereas others may be more difficult to determine empirically or otherwise. The practical aspects and difficulties associated with the determination of these parameters will be discussed in the course of these articles.

In later articles, we will discuss the types of nonlinear phenomena and effects that may arise. These include receiver nonlinear responses and the "rusty bolt" effect. A future article will generalize the application of the nonlinear methodology to an intrasystem assessment tool which models a complex system structure, its co-located electromagnetic ports, and incident electromagnetic environments.

At the conclusion of this series, we will describe the insertion of a quasi-discrete method for computing receiver nonlinearities within an existing computational electromagnetics framework, specifically, the Electromagnetic Environment Effects EXpert Processor w/Embedded Reasoning Tasker (E^{3}EXPERT) [2]. E^{3}EXPERT's computational formalisms are based partially on an enhanced version of the Air Force's Intrasystem Electromagnetic Compatibility Analysis Program (IEMCAP). The addition of this nonlinear capability provides a means to model and analyze the effect of complex, high-power electromagnetic environments on complex systems. The approach can also be extended to circuit modeling to complement rigorous numerical computational electromagnetics (CEM) methods which focus on linear effects.

The quasi-discrete method for computing nonlinear responses and effects involves generating a matrix of "weighted" source-to-receiver couplets. This matrix takes into account all intrasystem coupling losses, and utilizes both discrete and numerical solution methods to compute electromagnetic figures of merit.

Distortion and Interference Effects in a Communications Receiver [1]

The basic purpose of a communications system is the transmission of information from one place to another. Because electronic equipments have

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experienced a "population" explosion in recent years, communications has become increasingly difficult. As the numbers of electronic equipments have grown, the electromagnetic spectrum has become more crowded with a corresponding decrease in the spatial separations between equipments. To further aggravate the problem, improved sensitivities have enabled equipments to respond to signals that previously went undetected. As a result, desired input signals are frequently accompanied by a host of unwanted signals.

To combat interference, equipments are designed to be frequency selective. A typical selectivity curve, assuming a linear system, is shown in Figure 1. Note that the equipment is tuned to f_0, the center frequency of the desired signal spectrum. At frequencies for which the attenuation is large, the rejection of the incoming signal is also large. Therefore, from linear considerations, unwanted signals falling outside the system passband should be severely attenuated. Such interferers are expected to cause only minimal degradation in system performance. Actual experience does not support this conclusion. In practice it is found that signals falling well outside the system passband may, in fact, result in significant interference. This irregular behavior, not predicted by linear systems theory, may be caused by nonlinearities inherent in solid-state devices such as transistors contained within the equipment.

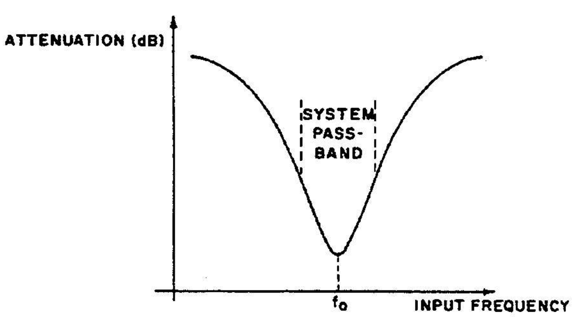

Figure 1. Linear Frequency Selectivity Curve [1].

In order to elaborate on this point, we consider the superheterodyne receiver illustrated in Figure 2. The functional blocks preceding the detector provide the frequency selectivity, tuning, and amplification needed for proper receiver operation. When a receiver is tuned across its frequency range, it is desirable that the receiver bandwidth and gain remain constant. This is difficult to achieve with tunable networks incorporated into each of the amplifier stages. Consequently, superheterodyne receivers are used that translate the carrier frequency of the incoming signal to a fixed predetermined intermediate frequency (IF). The frequency conversion (or heterodyning) is carried out by mixing the received RF signal with a local oscillator signal having its frequency separated from that of the incoming signal by an amount equal to the center frequency of the IF amplifiers. Tuning the receiver requires adjusting only the RF amplifier stages and local oscillator.

The advantage of the superheterodyne approach is that the receiver gain and bandwidth are determined by the fixed-frequency IF amplifier stages following the mixer. The constant bandwidth results because the RF stages have much larger bandwidths than do the IF stages. For example, in a VHF communications receiver capable of being tuned over the 30-100 MHz frequency range, typical RF and IF bandwidths are 5 MHz and 500 kHz, respectively. Since the IF stages are much narrower than the RF stages, they determine the overall selectivity. It follows that, even though the bandwidths of the adjustable RF stages vary as the receiver is tuned across its frequency range, the overall bandwidth remains essentially constant.

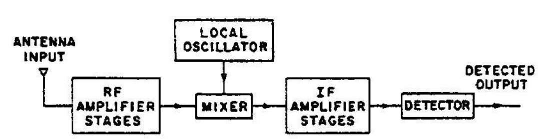

Figure 2. Simplified Block Diagram of Superheterodyne Receiver [1].

Conventional operation of a superheterodyne receiver is obtained by tuning the receiver to the desired signal. This results in the carrier frequency of the desired signal being separated from the local oscillator (LO) frequency by an amount equal to the IF frequency. Typically, the local oscillator frequency is larger than the tuned receiver frequency. For this situation, the image frequency is defined to be the sum of the local oscillator and IF frequencies. A superheterodyne receiver exhibits an image response in addition to its conventional response, because a signal located at the image frequency is also translated by the mixer to the fixed IF passband. A typical selectivity curve for a superheterodyne receiver tuned to 45 MHz appears in Figure 3. Note that the local oscillator frequency is 66 MHz and that the image response occurs at 87 MHz. We conclude from this that the IF frequency is 21 MHz. The image response is not as strong as the conventional response because a signal located at the image frequency is severely attenuated by the RF selectivity. Nevertheless, if an undesired signal at the image frequency is considerably larger than the signal to which the receiver is tuned, significant interference can result. Clearly, the greater the IF frequency, the larger is the image rejection that can be provided by the RF circuitry. The infinite attenuation appearing at 66 MHz occurs because the receiver does not transmit the DC component generated when the frequency of the incoming RF signal is identical to the local oscillator frequency.

We now discuss some interference considerations in conjunction with the selectivity curve of Figure 3. Interfering signals are customarily classified as being either: (1) co-channel; (2) adjacent channel; or (3) out of band, depending upon their frequencies relative to the receiver tuned frequency. Uniform agreement does not exist concerning the precise interpretation of these terms. For our purposes, we make the following definitions: a co-channel signal is one whose frequency falls within the 3-dB receiver bandwidth. Signals whose frequencies fall outside the 3-dB receiver bandwidth, but inside the RF bandwidth are referred to as adjacent channel interferers. Out of band signals are those whose frequencies appear outside the RF bandwidth.
After frequency conversion, note that co-channel signals are located inside the 3-dB bandwidth of the IF stages whereas adjacent channel and out of band signals, except for those located near the

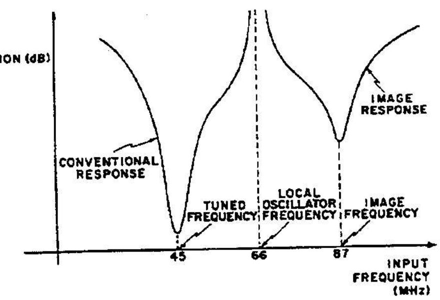

Figure 3. Typical Frequency Selectivity Curve for a Superheterodyne Receiver [1].

image frequency, are not. Co-channel signals can be a serious source of interference because they appear at the IF output having experienced approximately the same gain as the desired signal. To aid in minimizing co-channel interference, frequency allocation and assignment procedures are commonly used. Such procedures are not completely effective because transmitter emissions are non-ideal. In addition to transmitting power at the desired operating frequency, transmitters also emit harmonics of the desired operating frequency, signal components at various other frequencies, and broadband noise. Filters are employed in transmitters to suppress these undesired transmissions. Nevertheless, an unwanted emission 80 dB below the fundamental output of a 100 kW transmitter still has a power level of 1 mW. This is more than enough power to severely degrade the performance of a nearby communications receiver that is capable of responding to signals with powers much less than a milliwatt.

Adjacent channel and out of band signals are also amplified, heterodyned, and detected in the same manner as the desired signal. Because they fall on the skirts of the receiver selectivity curve, they experience considerable attenuation. When processed in this manner, such signals cause significant interference only if they are much stronger than the desired signal. Adjacent channel signals need not be quite as large as out of band signals because they suffer less attenuation. However, out of band signals can be troublesome when centered within the receiver's image response. Also, because of the large frequency range encompassed by such signals, there are apt to be a large number of out of band signals at the receiver input. This increases the likelihood of some out of band signals being present that are strong enough to overcome receiver selectivity so as to cause significant interference.

The preceding discussion of interference has hinged upon the linear response of the frequency selective portions of the receiver. For this reason the interference effects discussed thus far are commonly referred to as linear effects. With respect to adjacent channel and out of band signals, additional interference problems may arise because of nonlinearities inherent in the electronic devices. The major nonlinear interference effects are known as intermodulation, desensitization, cross modulation, and spurious responses. A nonlinear distortion effect, called gain compression, is produced by a strong desired signal in the absence of interferers. These effects are now described briefly.

Intermodulation: In a linear time-invariant system the frequency content at the output is always identical to that of the input. To put it another way, linear time-invariant systems do not generate new frequencies. This is not true with nonlinear systems. The process by which two or more signals combine in a nonlinear manner so as to produce new frequency components is termed intermodulation.

It is the process of intermodulation that enables signals appearing outside a receiver's passband to generate interference that falls inside the IF bandwidth. For example, consider a receiver with an amplifier having both quadratic and cubic nonlinearities. Let the input consist of two sinusoidal signals at frequencies f_1 and f_2, respectively, where f_2 is greater than f_1. Figure 4 shows the frequency content at both the amplifier input and output. The terms marked (1) indicate components resulting from the linear behavior of the amplifier. Terms that are generated by the quadratic and cubic nonlinearities are marked by (2) and (3), respectively. Although there are only two frequency components at the input, intermodulation produces thirteen different frequencies at the output. Should any of these frequencies fall into the receiver's IF passband, severe degradation in performance may result. Even in the absence of interfering signals, intermodulation may produce serious distortion when the desired input signal consists of several frequency components.

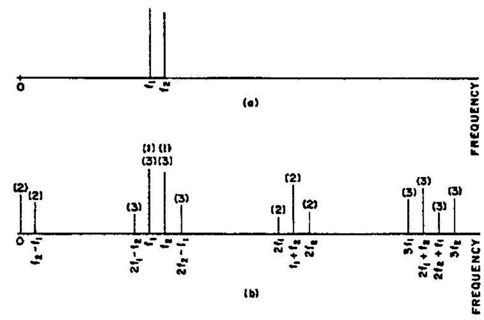

Figure 4. Intermodulation Example Involving Amplifier With Quadratic and Cubic Nonlinearities. (a) Frequency Content at Input. (b) Frequency Content at Output [1].

Desensitization: The nonlinear effect by which an interfering signal reduces the apparent gain of a receiver is known as desensitization. For example, consider an experiment whereby a communications receiver is excited by two sinusoidal signals at the distinct frequencies f_1 and f_2. Assume the amplitude of the input signal at f_1 is maintained constant throughout the experiment. Beginning with extremely small values of the signal at f_2, let its magnitude be gradually increased. From linear considerations the amplitude of the response at f_1 should be unaffected by the presence of the second signal at f_2. However, in actual practice, it is observed that the amplitude of the response at f_1 decreases as the amplitude of the input signal at f_2 exceeds some critical level. Since receiver gain is reduced, we say that the receiver has been desensitized by the interfering signal at f_2.

A typical plot of the desensitization, or gain reduction, in a communications receiver is shown in Figure 5. The data pertain to an experiment in which the sinusoidal signal at f_1 was positioned at the tuned receiver frequency of 19.75 MHz and had an available input power of –55 dBm. The

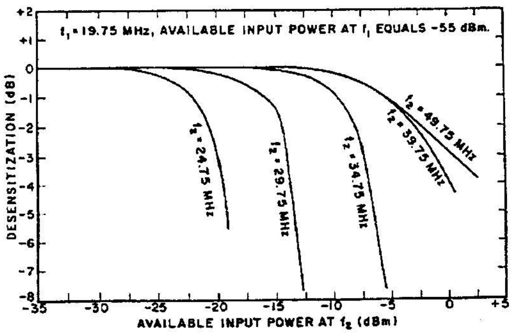

Figure 5. Typical Desensitization in a Communications Receiver [1].

plot shows the amount of desensitization experienced by the signal at f_1 as a function of the available power in the signal at f_2. Separate curves are given for f_2 = 24.75, 29.75, 34.75, 39.75, and 49.75 MHz. Observe that the amount of desensitization depends upon the frequency of the interferer and occurs abruptly as the input power at f_2 exceeds a critical level.

Cross Modulation: Cross modulation is the nonlinear effect whereby modulation from one signal is transferred to another. In this way, severe distortion can be generated by an interferer that is widely separated in frequency from the desired signal. The effect is illustrated in Figure 6. As shown in Figure 6(a), the desired signal is assumed to be an unmodulated carrier with frequency f_1. The interferer, which appears in Figure 6(b), is an amplitude-modulated signal at frequency f_2. Note that the modulation consists of a triangular waveform. When these two signals are applied to a receiver having a cubic nonlinearity, a distorted version of the modulation from the signal at f_2 is transferred to the carrier at f_1. This is shown in Figure 6. Whereas the envelope of the desired signal was originally constant, it now varies in a periodic manner. Obviously, cross modulation can be extremely troublesome in communication systems.

Spurious Responses. Spurious responses are a special case of intermodulation. The amplitude of an intermodulation component depends upon the power levels of the signals involved. The weaker the signals incident upon a nonlinearity, the smaller are the intermodulation components generated. Since out of band signals are greatly attenuated by a receiver's frequency selectivity, they do not normally combine to produce significant interference via the intermodulation process.

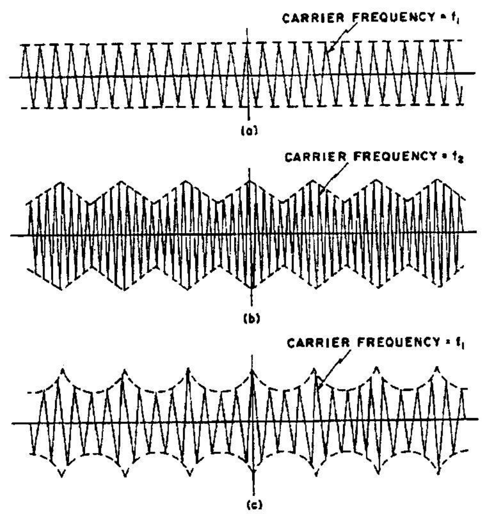

Figure 6. Cross-Modulation Example.
(a) Unmodulated Carrier at f_1.
(b) Carrier at f_2 Amplitude Modulated by Triangular Waveform.
(c) Output at f_1 of Receiver Having a Cubic Nonlinearity [1]

However, many receivers employ strong local oscillator signals. In such instances, the local oscillator signal is much larger than the received signals at the mixer input. For example, the power level of a local oscillator signal at the input to a mixer may be 120 dB greater than that of the desired signal. In practice, a strong local oscillator signal can neutralize the attenuation experienced by an out of band signal. Consequently, out of band signals that combine nonlinearly with the local oscillator signal may produce significant intermodulation components. A receiver's image response is one example of this effect.

Spurious responses are defined to be those responses that are generated by an interfering signal, or one of its harmonics, combining with the local oscillator signal, or one of its harmonics. Of particular concern are those frequency combinations that result in interference components falling within or near the IF passband. It is the mechanism of spurious responses that allows out of band signals to severely disrupt what would otherwise be conventional receiver operation.

Gain Compression/Expansion: Thus far our discussion of nonlinear effects has involved interfering signals. Nonlinearities may adversely effect receiver performance even when interferers are absent. One such nonlinear effect is called gain compression or expansion. In a linear receiver the receiver gain remains constant as the input signal amplitude is varied. This is not the case with actual receivers that are inherently nonlinear. The terms, gain compression and expansion, are used to describe the variation in gain of a receiver as the input signal is increased in amplitude.

As a demonstration of these effects, an experiment was performed on an IF amplifier with a center frequency of 21.4 MHz, a 3-dB bandwidth of 500 kHz, and a midband power gain of 16 dB. Figure 7 shows the amplifier's measured input-output power characteristics for sinusoidal inputs at 21.4 and 20.0 MHz, respectively. When an amplifier performs linearly, the output power in decibels increases by the same amount as the input power in decibels. Thus the straight lines at 45^o in Figures 7(a) and (b) correspond to the response of a perfectly linear amplifier. For small enough input signals, we see that the amplifier behaves linearly.

The plot in Figure 7 is for the case in which the input signal is applied at the amplifier's tuned frequency of 21.4 MHz. The amplifier has a linear gain of 16 dB at this frequency since an input power of -70 dBm results in an output power of -54 dBm. We say that gain expansion occurs when the amplifier gain is greater than the linear gain. Similarly, gain compression is said to occur when the amplifier gain is less than the linear gain. In our example, gain expansion occurs gradually as the input power level exceeds

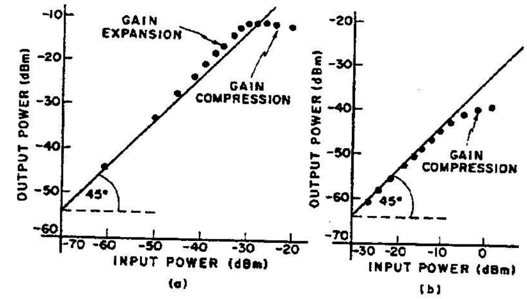

Figure 7. Measured Input-Output Power Characteristics of IF Amplifier.
(a) Input Signal at 21.4 MHz.
(b) Input Signal at 20.0 MHz [1].

-60 dBm and transforms abruptly into gain compression at an input level of approximately -29 dBm. The plot is interesting because it illustrates that both expansion and compression can occur at a single frequency for different values of the input level.

The input-output power characteristic shown in Figure 7 for an input frequency of 20.0 MHz follows the more conventional type of gain compression curve. Note that an input power of -30 dBm produces an output power of -64 dBm. Therefore, since the 20.0 MHz signal falls outside the IF passband, it experiences a linear attenuation of 34 dB. Gain compression first becomes apparent when the input power level is approximately -15 dBm.

When the gain varies as a function of the input signal level, serious nonlinear distortion can be generated in the desired signal.

SUMMARY

In this paper we have discussed the nonlinear effects of intermodulation, desensitization, cross modulation, spurious responses, and gain compression/expansion. These important effects, several of which may occur simultaneously in a communications receiver, cannot be analyzed, predicted, or explained by linear analysis techniques. These topics have been presented to illustrate several fundamental aspects of nonlinear phenomena and effects. In future articles in this series, we will discuss in greater depth the various nonlinear modes and mechanisms that may arise in practical systems and components that incorporate nonlinear devices.

A much later article will present new findings of research and development to add nonlinear analysis and prediction capabilities to existing computational electromagnetics tools which determine detailed interference rejection requirements as part of an automated EMC assessment methodology for large, complex systems. Computer simulations continue to be conducted to study the effectiveness of the approach for several interference scenarios. Simulations are directed at assessing the EMC for a collection of external RF transceivers mounted on a complex airborne structure. These include fixed- and variably-tuned RF ports, spread spectrum frequency-hopped and direct sequence transceivers, and incident CW and wideband fields.

REFERENCES

[1] D. D. Weiner and J. F. Spina, *Sinusoidal Analysis and Modeling of Weakly Nonlinear Circuits*, Van Nostrand Reinhold Publishers, New York, NY, ISBN 0-442-26093-8, 1980.

[2] A. L. Drozd, J. Miller, et. al., "Predicting Detailed Electromagnetic Interference Rejection Requirements Using a Knowledge-Based Simulation Approach", Newsletter Technical Features Article for the Applied Computational Electromagnetics Society, Vol. 14, No. 1, ISSN 1056-9170, March 1999, pp. 8-11.

Speeding Up NEC Using LAPACK

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Over the past year or two, several people have independently realized that replacing NEC's linear algebra routines (`FACTR` and `SOLVE`) with routines from the LAPACK linear algebra library is relatively simple and very rewarding. I've put a little description together, with benchmarks and example code, to show how beneficial this can be.

LAPACK is a standardized set of routines for linear algebra that has been developed to provide high quality, high speed implementations of commonly needed functions. There are FORTRAN versions available on the net at www.netlib.org/lapack, as well as a FAQ (www.netlib.org/lapack/faq.html).

The big payoff from using LAPACK comes from using a version of the library optimized for your processor, rather than simply compiling the generic FORTRAN versions. Because it is the standard library for linear algebra, all workstation and supercomputer vendors provide an optimized version of LAPACK for their machines; some of them charge for it (e.g. Sun, which provides it as part of the Sun Performance Workshop) and some of them give it away (e.g. SGI, which lets you download the SCSL Scientific Library for free).

Luckily for the many people using PCs under Windows 9X or NT, Intel has a free version which supports Digital Visual Fortran (as well as the Intel Fortran Compiler, which isn't terribly popular). It's called the Intel Math Kernel Library, and it can be downloaded from developer.intel.com, in the directory /vtune/perflibst/mkl/index.htm.

What can an optimized LAPACK interface do for you? Here's a list of runtimes for NEC problems of various sizes, using the original NEC code and a version modified to use Intel's optimized LAPACK library. As you can see from the table below, the benefits are dramatic. (All of these problems had no symmetry, and were run on the same dual processor 400 MHz Pentium II. Times are total run time in seconds.)

Size (segments)	Original	LAPACK (1 proc.)	LAPACK (2 proc.)
400	4.0	1.9	1.7
800	25.4	10.0	7.8
1600	243	60	43
3200	1917	382	244

Note that using an optimized library may also allow you to use multiple processors if you have them (the Intel library does this, but only under NT, of course). The speed increase is significant, and it gets larger as the problem size increases. This is because using LAPACK speeds up the factoring of the interaction matrix (the FACTOR time reported by NEC), and that time increases as the cube of the number of segments. For 4000-5000 segment problems, the speed improvement can easily be a factor of 10.

How do you get this to work? To do it, you will need to have the NEC source code, and already be able to compile it and produce working versions of the original NEC program. You will also need to locate a LAPACK library compatible with your compiler, or choose a compiler for which an optimized LAPACK library is available (check the LAPACK FAQ under Vendor-Supplied BLAS; many of those also provide the LAPACK library). If you use Digital Fortran on a PC, for example, get the Intel library; on a Mac, Absoft provides a LAPACK library with Pro Fortran 6.0.

If you use a Mac or a PC, you may find that your favorite compiler doesn't have an optimized LAPACK library; it's up to you to decide whether the speed improvement is worth changing compilers. You may also download the FORTRAN versions from www.netlib.org and compile them (there are a LARGE number of files), but don't expect the dramatic speed improvements you can get with an optimized library.

Take your copy of NEC and locate the `FACTR` and `SOLVE` subroutines. Cut `SUBROUTINE FACTR` and `SUBROUTINE SOLVE` (only!) out of the file and save them in a separate file. Don't modify any other routines (like `FACTRS` or `SOLGF`)! Next, copy the two replacement routines below into another file:

```
      SUBROUTINE FACTR (N,A,IP,NDIM)
C
C     Performs LU decomposition of the COMPLEX*16 matrix A, using
C     routines from the LAPACK linear algebra library.
C
C     Although these implementations of FACTR and SOLVE are
C     functionally equivalent to the original NEC routines, they
C     do not produce identical intermediate results. This means
C     you MUST replace both FACTR and SOLVE in the NEC code, and
C     recompute any numerical Green's function files, for NEC to
C     operate correctly.
C
      INTEGER N,NDIM,IP(*)
      COMPLEX*16 A(NDIM,*)
      CALL ZGETRF(N,N,A,NDIM,IP,INFO)
      IF(INFO .NE. 0) THEN
        WRITE(3,*) ' ERROR IN FACTR'
        STOP
      ENDIF
      RETURN
      END

      SUBROUTINE SOLVE (N,A,IP,B,NDIM)
C
C     Solves the linear equation transpose(A) * x = b (which is what
C     NEC wants) from the LU decomposition computed by FACTR, using
C     LAPACK.
C
      INTEGER N,NDIM,IP(*)
      COMPLEX*16 A(NDIM,*),B(*)
      INTEGER INFO
      CALL ZGETRS('T',N,1,A,NDIM,IP,B,NDIM,INFO)
      IF(INFO .NE. 0) THEN
        WRITE(3,*) ' ERROR IN SOLVE'
        STOP
      ENDIF
      RETURN
      END
```

READ the warning in the source code! You must recompute any NGF files before you can use the LAPACK interface version! (And don't use a NGF problem as a test problem below).

Now, you can easily make two versions of NEC: one using the original routines, by linking the main NEC file (FACTR and SOLVE removed) with the original FACTR/SOLVE file, and a LAPACK version, by linking the main NEC file with the LAPACK interface file listed above and the LAPACK library. Run the two versions on a simple test problem. The output files should be identical except for the lines giving the run times. (Of course, we also hope the run times are significantly shorter for the LAPACK version.) That's it – you should have a faster version of NEC!

Of course, you must do careful testing using both versions before you start using the LAPACK version in production work – it is your responsibility to verify that the interface is operating properly on your system.

I hope that this is beneficial to the NEC user community; I think it's an important update to NEC that should save many users many hundreds of hours of waiting for their runs to finish.

A New Web Site for Standard Challenge Problems and Measurement Data for Validation of Computational E/M Codes

http://www.emcs.org/tc9/

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Introduction

There are a number of numerical techniques available for modeling EMI problems, including various commercial software. Each of the different modeling techniques have areas where they match the problem quite well, and can provide accurate and reliable results. Also, each of the different modeling techniques have areas were they do ***not*** match the problem well, and can yield questionable results. A potential user must be able to evaluate the various options against their style problems in order to better understand which method is most suitable, and possibly evaluate commercial software.

In addition to applying a specific modeling technique or software package to an appropriate problem, it is desirable to be able to validate the results against previous modeling efforts or measured data. While many technical papers have shown results from models, and many include measurements or other validations, the details of the models and measurements are often not sufficiently reported to allow someone to repeat the model and directly compare results.

A joint IEEE/EMC Society TC-9 Committee and Applied Computational Electromagnetic Society (ACES) effort has resulted in a central web location for contributors to provide model and measurement data to share and compare with others. In addition to the data repository, a set of standard challenge problems have been proposed over the past few years, and they are also located at this web site.

Validation Data

The intention of this collection of measured data is to provide easy availability of previously measured data to anyone who wishes to compare simulation data to measurements. Anyone who has measurement (or modeling) data and who wishes may submit the data for inclusion on the web site.

A committee has been established to review all submittals to this repository. The submittal must include sufficient detail about how the modeling was accomplished (if any), and how the measurements were conducted (if any) so that the modeling and/or experiments can be easily repeated. The results from these models and/or measurements must be clearly presented, and a simple ASCII text file with the data must be available for downloading. The submittal will be posted on the web once accepted by the review committee, and will be available for downloading by interested engineers.

All submittals are expected to contain sufficient information that the user can reproduce the reported results. Model and measurement data or multiple modeling techniques (showing the same results) are preferred so that there is validation within the submittal. Engineers using this data are encouraged to provide their results as further validation of the specific model and results.

Challenge and Specific Standard Problems

The second major purpose of this web location is to provide a central location where interested researchers and engineers can download the details of the IEEE/EMC Society TC-9 Challenge and Specific Standard Modeling Problems. These problems have been designed to allow users to highlight strengths and weaknesses of various modeling techniques and tools.

The Challenge Problems are difficult problems that may require an EM modeling expert. These problems include shielding problems, PC boards with long wires attached, PC boards with microstrips, system-level shielded enclosures connected to remote PC boards via long wires, and others. Many of these problems can not be solved by certain modeling techniques, or require limiting assumptions, while those same problems can be solved in a straightforward manner by other modeling techniques. Some problems may require multiple modeling stages (where the output of one model becomes the input to a second model), or hybrid modeling techniques.

These challenging problems were created specifically to highlight how certain techniques are well suited to some problems, but not well suited to other problems. Since there is no simple modeling technique that can do all the various types of modeling required by the typical EMC engineer, a variety of tools are often required.

In 1998, two challenge problems were proposed. Problem 98-01 (Figure 1) consisted of a shielded metal box with an aperture. The source was a common mode voltage between an internal motherboard-daughter card combination. A second daughter card provided partial shielding between the source and the aperture. Problem 98-02 consisted of a PC board with traces, and long wires running off the PC board. A split in the board's reference plane was included.

In 1999, four challenge problems were proposed. Problem 99-01 (Figure 3) concerned the emissions along the edge of a PC Board, due to a trace on that board. Problem 99-02 (Figure 4) was to find the difference in shielding performance of a number of different seam shapes. Problem 99-03 (Figure 5) was a system level problem, with an enclosed shielded box, and a PC board connected by a long cable. Problem 99-04 (Figure 6) was to find the crosstalk between active and passive pins in a complex high speed connector.

The Specific Standard Problems are more limited in scope, and intended to be 'simpler' to solve. They are more useful for evaluating commercial software by a potential user, since they are more limited and can be solved by a non-expert, and in a reasonable amount of time. These problems are again selected to highlight the strengths and weaknesses of the various modeling techniques.

These Specific Standard Problems include a heatsink emissions problem, a PC board decoupling problem, a microstrip problem, and a shielding problem. The dimensions are selected so that these problems can be converted into reasonable sized models, and solved in a short amount of time. Examples of results for each of these problems are posted along with the problems, so that potential tool purchasers can compare their evaluation results to the posted results. As additional results become available, they will be added to the web location.

Summary

A central location has been developed to allow interested persons to use previous results as a source for numerical modeling validation. This site will be carefully monitored by a review committee to insure only high quality information is posted on this site.

Also available from this site will be the IEEE/EMC Society TC-9 Challenge and Specific Standard Modeling problems. The problems are specified in sufficient detail so that users can easily create models which allow direct comparison to data from other contributors, and allow evaluation of commercial software as well.

This site has been developed as a joint ACES and IEEE/EMC TC-9 effort. Any one with comments and/or suggestions are invited to contact either of the authors.

Figure 1 Problem #98-01

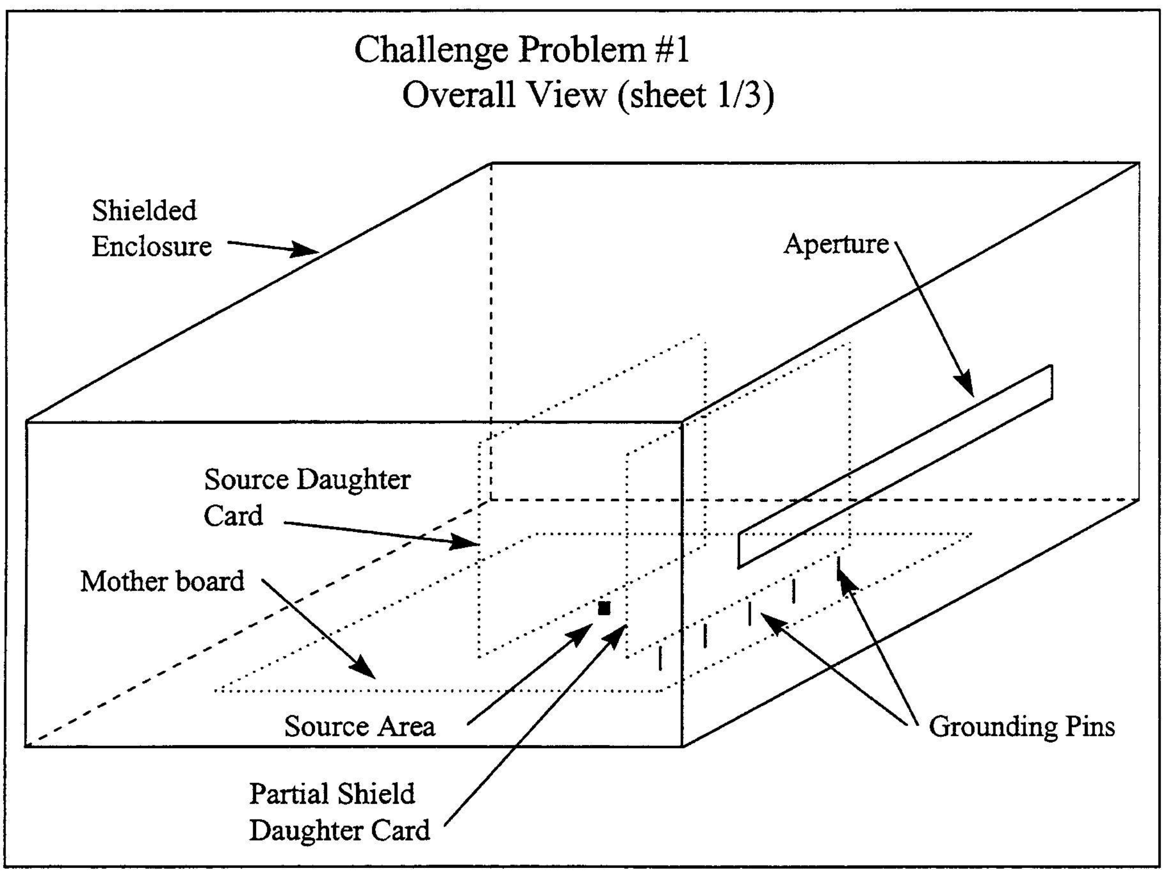
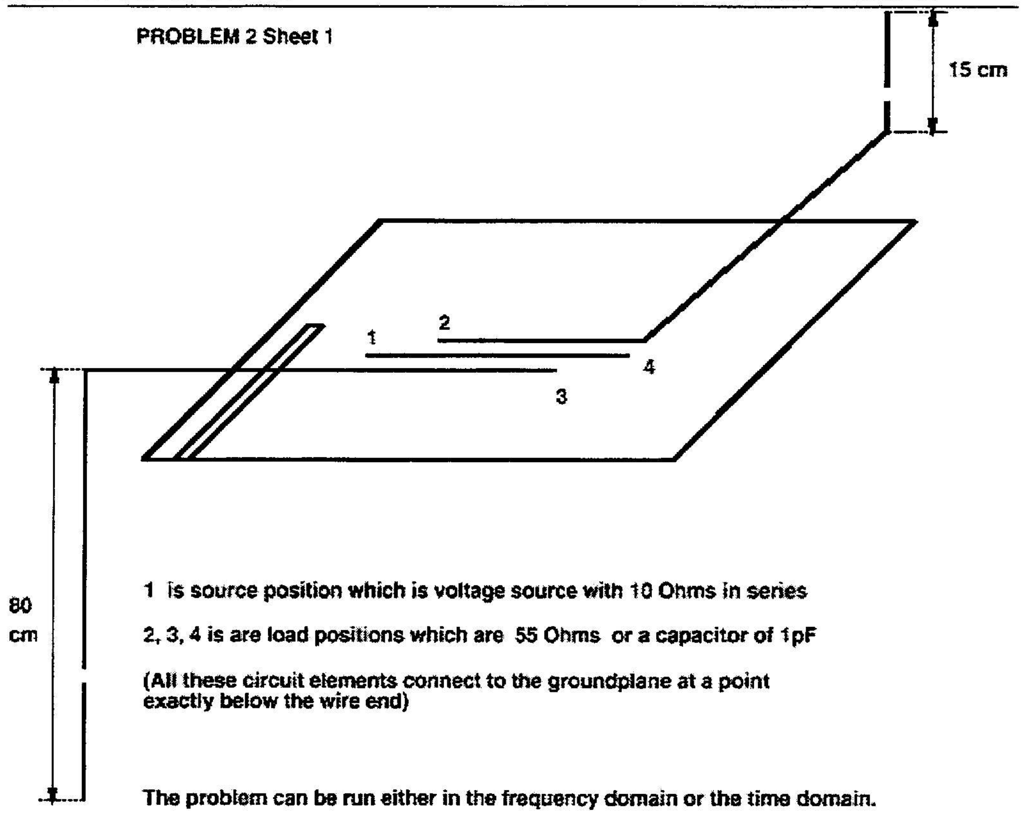


Figure 2 Problem 98-02

PROBLEM 2 Sheet 1



1 is source position which is voltage source with 10 Ohms in series

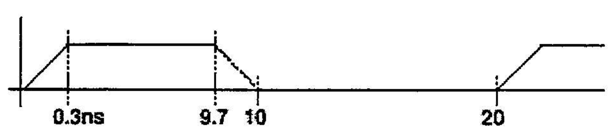
2, 3, 4 is are load positions which are 55 Ohms or a capacitor of 1pF

(All these circuit elements connect to the groundplane at a point exactly below the wire end)

The problem can be run either in the frequency domain or the time domain.

The result of interest in the frequency domain is the radiation at 3m from the center of the plane.

In the time domain we also look for time domain pulses at the different loads. The input waveform is a ramp with magnitude 1 V and a rise time of 0.3 ns.



Optional groundplane at 80 cm below the ground plane in the board

Figure 3 Problem 99-01 Emissions Along Edge of PC Board due to Trace

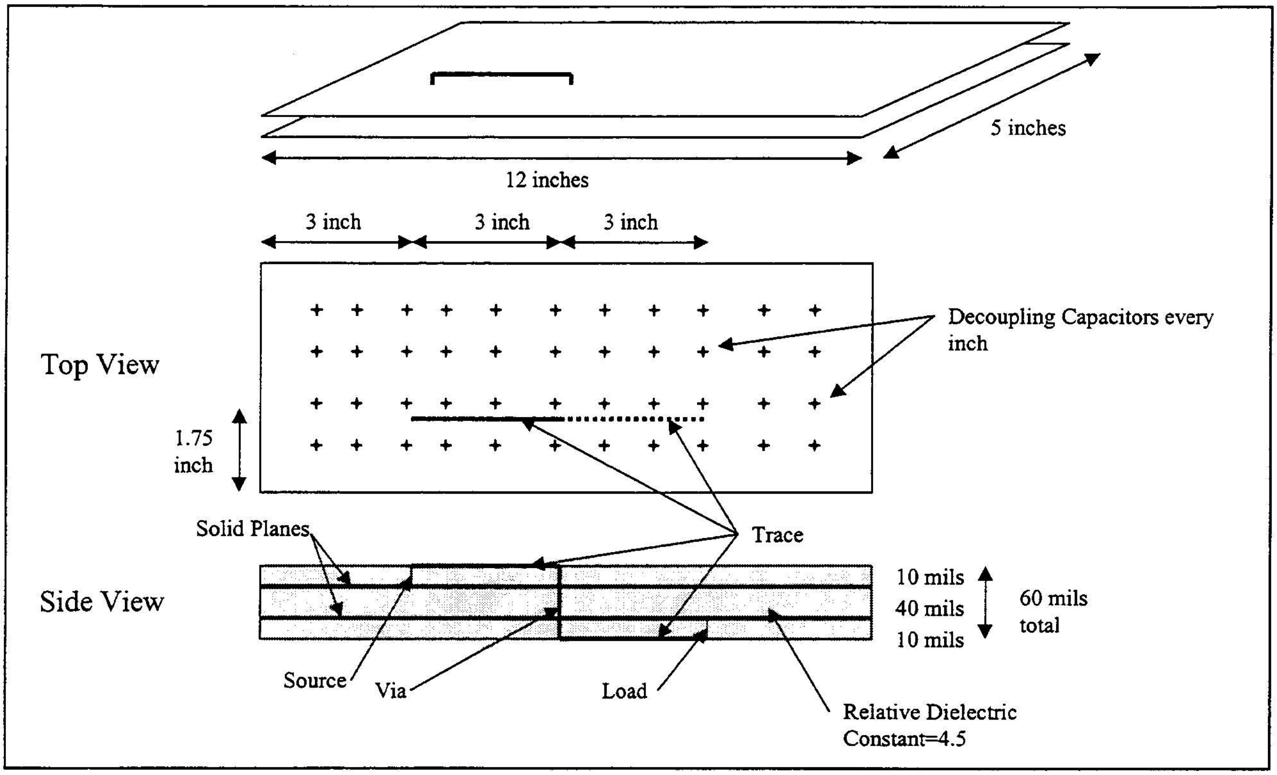


Figure 4 Problem 99-02 Shielding of Various Seam Shapes

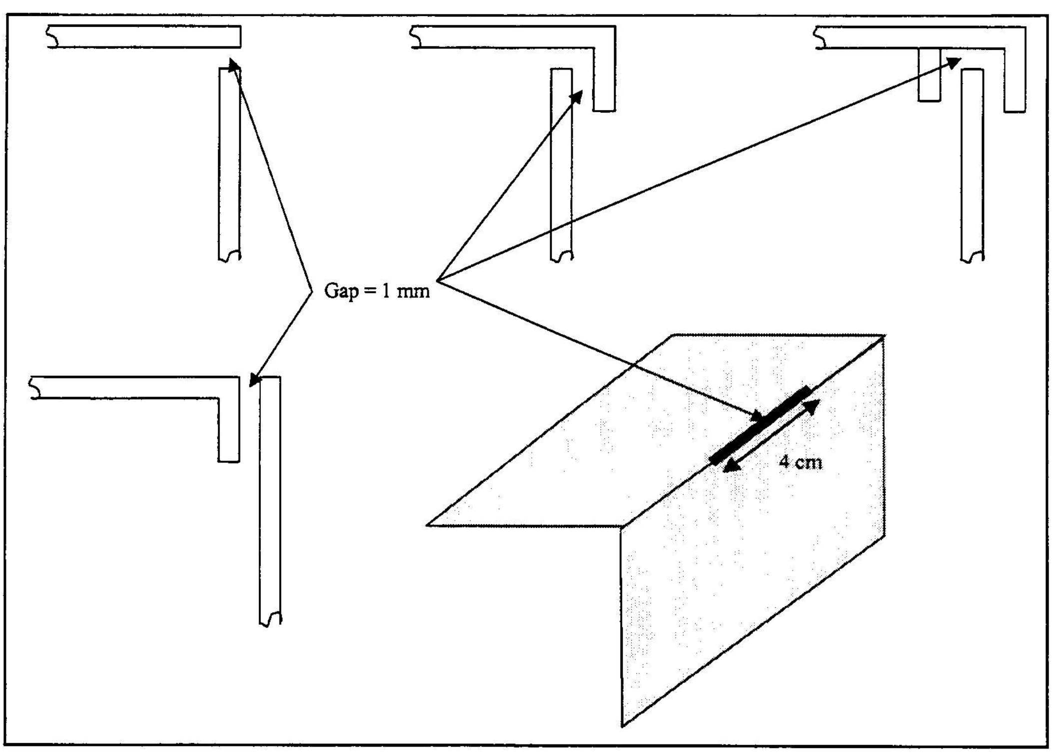


Figure 5 Problem 99-03 Emissions from a Interconnected System

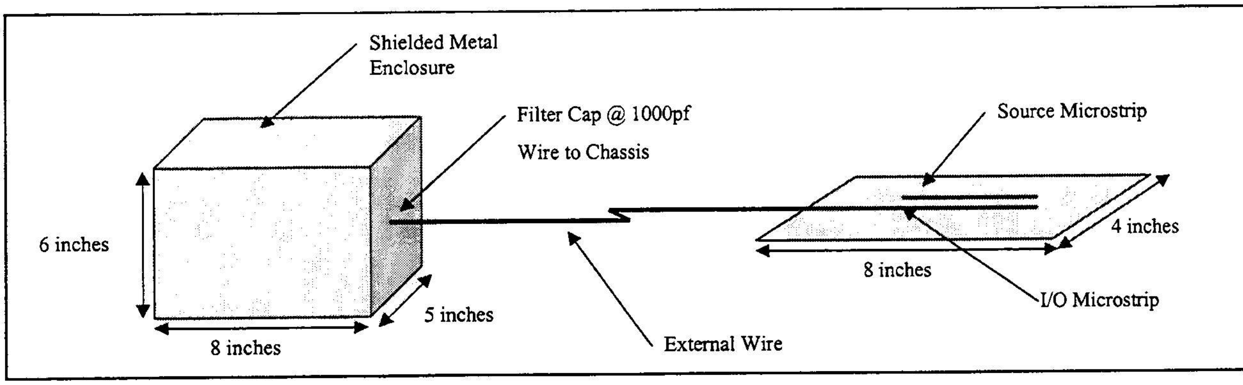
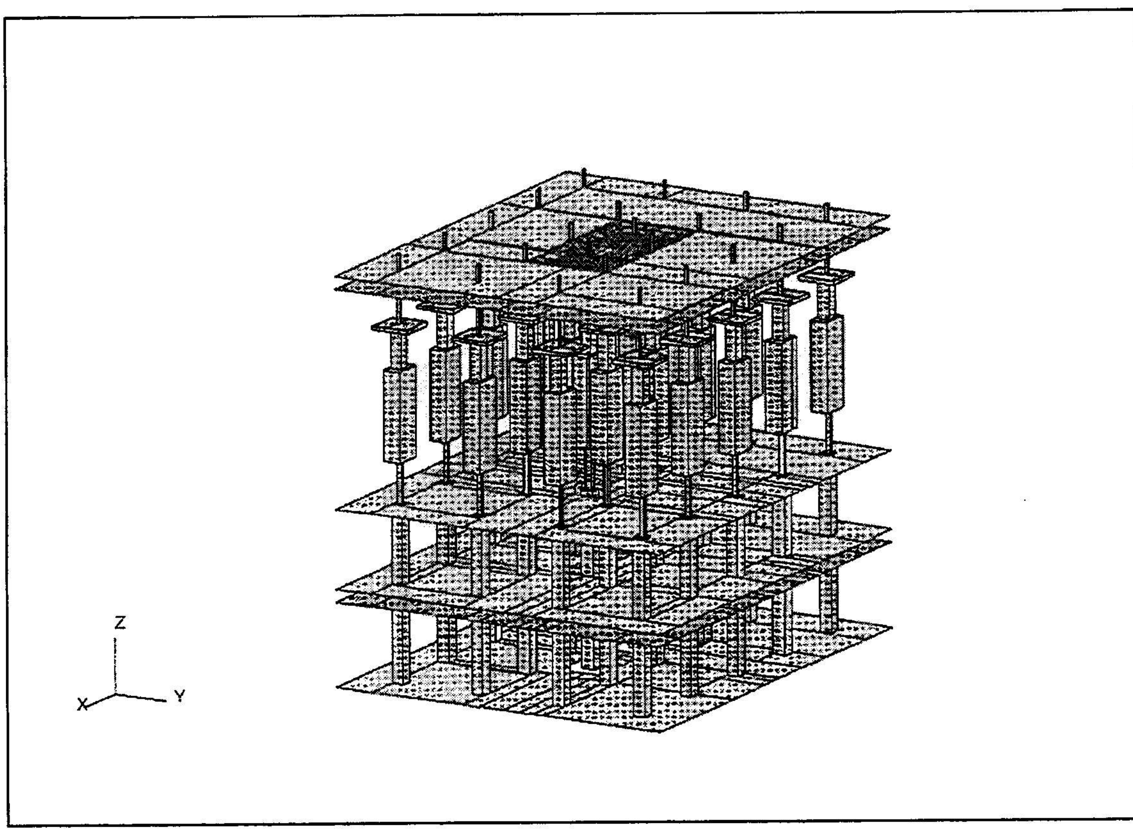


Figure 6 Problem 99-04 Crosstalk within High Speed Connector



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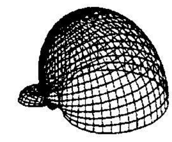

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The recommended paper length is 6 pages, with 8 pages as a maximum, including figures. The paper should be camera-ready (good resolution, clearly readable when reduced to the final print of 6x9 inch paper). The paper should be printed on 8-1/2x11 inch papers with 13/16 side margins, 1-1/16 inch top margin, and 1 inch on the bottom. On the first page, place title 1-1/2 inches from top with authors, affiliations, and e-mail addresses beneath the title. Single spaced type using 10 or 12 point font size, entire text should be justified (flush left and flush right). No typed page numbers, but number your pages lightly in pencil on the back of each page.

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MONDAY MORNING 20 MARCH 2000

0700 – 0730	**CONTINENTAL BREAKFAST** (For short course and hands-on-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	
0830-1630	**SHORT COURSE #2 (FULL-DAY)** "XML and Modern Internet Technologies for Scientific Applications" Furrukh S. Khan, Ohio State University	
0830-1630	**SHORT COURSE #3 (FULL-DAY)** "The Basics of The Finite Difference Time Domain Technique for Electromagnetic Application" Atef Z. Elsherbeni and Allen W. Glisson, University of Mississippi	
0830-1630	**SHORT COURSE #4 (FULL-DAY)** "Techniques for Electromagnetic Visualization" Edmund K. Miller, Santa Fe, NM, and John Shaeffer, Marietta Scientific, Inc	
0830-1630	**SHORT COURSE #5 (FULL-DAY)** "EIGER – Electromagnetic Interactions Generalized: An Introduction to and Tutorial on the Software Suite" Robert M. Sharpe and Nathan J. Champagne, Lawrence Livermore National Laboratory William A. Johnson, Sandia National Laboratories, Donald R. Wilton, University of Houston, And J. Brian Grant, ANT-S	
0830-1130	**HANDS-ON-WORKSHOP #6 (HALF-DAY, MORNING)** "MATHCAD Basics" Jovan Lebaric, Naval Postgraduate School	
0830-1630	**SHORT COURSE #8 (FULL-DAY)** "EMI/EMC Computational Modeling for Real-World Engineering Problems" Omar Ramahi, Compaq Corporation, and Bruce Archambeault, IBM	
0900-1200	**CONFERENCE REGISTRATION**	**Glasgow 103**

MONDAY AFTERNOON

1330-1630	**HANDS-ON-WORKSHOP #7 (HALF-DAY, AFTERNOON)** "MATLAB Basics" Jovan Lebaric, Naval Postgraduate School	
1400-1800	**CONFERENCE REGISTRATION**	**Glasgow 103**
1700	**BOD MEETING**	**SP 101A**
1900	**PUBLICATION DINNER**	

TUESDAY MORNING 21 MARCH 2000

0715 – 0745	**CONTINENTAL BREAKFAST**		**Glasgow Courtyard**
0740	**ACES BUSINESS MEETING**	**President Perry Wheless**	**Glasgow 102**
0745	**ACES Website Demo**	**Atef Elsherbeni**	**Glasgow 102**
0800	**WELCOME**	**Douglas Werner,** Penn State Univeristy	**Glasgow 102**
0815	**PLENARY SPEAKER:**	**Raj Mittra,** Penn State University	**Glasgow 102**

"Efficient Extraction of S-parameters of Transmission Line Discontinuities for RF and Wireless Circuit Design"

SESSION 1: FINITE ELEMENT METHODS — **Parallel with Sessions 2, 3 & 4)**

Chairs: Jianming Jin and Peter Monk

0920	"Transient Electromagnetic Scattering from Curved Dielectric/Lossy 3D Bodies Using Covariant Projection Elements"	R. Ordovas, S.P. Walker & M.J. Bluck
0940	"Towards an *hp*-Adaptive Finite Element Method for Full-Wave Analysis of Waveguides"	L. Vardapetyan & L. Demkowicz
1000	"An *hp*-Adaptive Finite Element Method for Maxwell's Equations: A Progress Report"	L. Demkowicz
1020	**BREAK**	
1040	"Finite Element Method for Designing Plasma Reactors"	Leo Kempel, Paul Rummel, Tim Grotjohn & John Amrhein
1100	"Finite-Element Domain Decomposition Through an Iterative Algorithm: Coupling Between Cavity-Backed Slots"	Anastasis C. Polycarpou & Constantine A. Balanis
1120	"Investigation of the Bunting/Davis Functional when used with Vector Finite Elements for Waveguide Analysis"	Andrew F. Peterson & Sharib Wasi
1140	"Numerical Methods for High Frequency Problems"	T. Huttunen & P. Monk
1200	**LUNCH**	

SESSION 2: OPTIMIZATION IN ELECTROMAGNETICS — **(Parallel with Sessions 1, 3 & 4)**

Chairs: Eric Michielssen and Dan Weile

0920	"Design of Dual Band Frequency Selective Surfaces Using Genetic Algorithm"	A. Monorchio, R. Mittra & G. Manara
0940	"A Study of Cauchy and Gaussian Mutation Operators in the Evolutionary Programming Optimization of Antenna Structures"	Ahmad Hoorfar & Yuan Liu
1000	"A Statistical Intercomparison of Binary and Decimal Genetic Algorithms"	Yee Hui Lee, Stuart J.Porter & Andrew C. Marvin
1020	**BREAK**	
1040	"The Compact Genetic Algorithm: A Litmus test for Genetic Algorithm Applicability"	Daniel S. Weile, Eric Michielssen & David E. Goldberg
1100	"Dipole Equivalent Circuit Optimization Using Genetic Algorithm"	Bruce Long, Ping Werner & Doug Werner
1120	"Computing the Electromagnetic Field in a Perturbed Configuration Using Modified Reduced-Order Models"	R.F. Remis & P.M. van den Berg
1140	Some Further Results From FARS: Far-Field Analysis of Radiation Sources"	Edmund K. Miller
1200	**LUNCH**	

SESSION 3: NUMERICAL TECHNIQUES FOR PACKAGING AND INTERCONNECTS — **(Parallel with Sessions 1,2, & 4)**

Chairs: Omar Ramahi and Andreas Cangellaris

0920	"A New Methodology for the Direct Generation of Closed-Form Electrostatic Green's Functions in Layered Dielectrics"	Andreas C. Cangellaris
0940	"The Treatment of Narrow Microstrips and PCB Tracks in the FDTD Method Using Empirically Modified Coefficients"	Chris J. Railton
1000	"Time-Domain-Analysis of QTEM Wave Propagation and Crosstalk on Lossy Multiconductor Transmission Lines with Terminal Coupling"	Georg Müller, Jan Wendel & Karl Reiβ

TUESDAY MORNING 21 MARCH 2000

SESSION 3: NUMERICAL TECHNIQUES FOR PACKAGING AND INTERCONNECTS (cont)

1020 **BREAK**

1040 "An MPIE-Based Circuit Extraction Technique and Its Applications on Power Bus Modeling in High-Speed Digital Designs" — Jun Fan, Hao Shi, James L. Knighten, James L. Drewniak

1100 "Non-resonant Electromagnetic Simulation of Some Resonant Planar Circuits" — Yuriy O. Shlepnev

1120 "FDTD Analysis of Conventional and Novel Delay Lines" — Omar M. Ramahi

1140 "Complementary Operators for Frequency-Domain Method: A Single Simulation Implementation" — Omar M. Ramahi

1200 **LUNCH**

SESSION 4: STUDENT PAPER COMPETITION — **(Parallel with Sessions 1, 2 & 3)**
Chair: Perry Wheless

0920 "Systematic Studies in Annular Ring PBG Structures" — Todd Lammers, Shawn W. Staker, & Melinda Piket-May

0940 "Fast Electromagnetic Analysis Using the Asymptotic Waveform Evaluation Method" — Dan Jiao & Jianming Jin

1000 "A Domain-Decomposition/Reciprocity Technique for the Analysis Of Arbitrarily-Shaped Microstrip Antennas with Dielectric Substrates and Superstrates Mounted on Circularly-Cylindrical Platforms" — R.J. Allard, D.H. Werner, & J.S. Zmyslo

1020 **BREAK**

1040 "A New FDTD Scheme to Model Chiral Media" — A. Akyurtlu, D.H. Werner, & K. Aydin

1100 "T-Matrix Computer Code Applied to Electromagnetic Field Penetration in Magnetic Resonance Imaging" — Rafael R. Canales, Luis F. Fonseca & Fredy R. Zypman

1200 **LUNCH**

TUESDAY AFTERNOON

1300-1530 **INTERACTIVE POSTER SESSION** — **Ballroom, Herrmann Hall**

1300-1900 **VENDOR EXHIBITS** — **Ballroom, Herrmann Hall**

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

SESSION 5: INTERACTIVE POSTER SESSION — **Ballroom, Herrmann Hall**

"Characteristics of Silicon Photoconductivity Under Near-Infrared illumination" — Preston P. Young, Robert Magnusson, Tim R. Holzheimer

"Characteristics of Fractal Antennas" — Haruo Kawakami, Yasushi Ojiro, Yasushi Iizuka, Satoshi Kogiso & Gentei Sato

"Feigenbaum Encryption of Computer Codes" — R.M. Bevensee

"Extension of SuperNEC to Calculate Characteristic Modes" — Thomas Abbott

"Computer Simulation of Radar Images of PEC Models of Complicated Objects" — Nickolai Zh. Kolev

"Xpatch 4: The Next Generation in High Frequency Electromagnetic Modeling and Simulation Software" — J. Hughes, J. Moore, S. Kosanovich, D. Kapp, R. Bhalla, R. Kipp, T. Courtney, A. Nolan, D. Andersh, F. German, and J. Cook

"An Astigmatic Beam Model to Be Used in Beam Tracing" — Emidio Di Giampaolo, Marco Sabbadini, & Fernando Bardati

"Review of Basic 3D Geometry Considerations for Intelligent CEM Pre-Processor Applications" — Kurt V. Sunderland

"Advanced Generation of Structured Hexahedral Grids for Electromagnetic Field Computations with the Finite Integration Technique" — M. Hilgner, R. Schuhmann, & T. Weiland

"Modelling of Loaded Wire Conductor Above Perfectly Conducting Ground by Using 3D TLM Method" — Nebojša S. Dončov, Bratislav D. Milovanović, Vladica M. Trenkić

TUESDAY AFTERNOON 21 MARCH 2000

1300-1530 **INTERACTIVE POSTER SESSION (cont)** **Ballroom, Herrmann Hall**

"Near to Far Field Transformation for a FDTD BOR with PML ABC and Sub-Grid Capability" — Vicente Rodriguez-Pereyra, Atef Z. Elsherbeni, Charles E. Smith

"Evanescent Tunneling and Quantile Motion of Electromagnetic Waves in Wave Guides of Varying Cross Section" — E. Gjonaj

"A Modal Approach for the Calculation of Scattering Parameters in Lossfree and Lossy Structures Using the FI-Technique" — Rolf Schuhmann, Peter Hammes, Stefan Setzer, Bernd Trapp, & Thomas Weiland

"A Modular Technique for the Calculation of Wave Guide Structures" — Johannes Borkes, Adalbert Beyer, & Oliver Pertz

"Wave Propagation Through 2D Clusters of Coupled Cylindrical Resonators" — Ross A. Speciale

"Design Software for Cylindrical Helix Antennas" — M. Slater, C.W. Trueman

"The Analysis of a Center-Fed Helical Microstrip Antenna Mounted on a Dielectric-Coated Circular Cylinder Using the Reciprocity Theorem" — R.A. Martin, & D.H. Werner

"Near to Far Field Transformation for a FDTD BOR with PML ABC and Sub-Grid Capability" — Vicente Rodriguez-Pereyra, Atef Elsherbeni & Charles Smith

WEDNESDAY MORNING

0715 – 0800 **CONTINENTAL BREAKFAST**

0815 **PLENARY SPEAKER** **Tom Cwik,** Jet Propulsion Laboratory **Glasgow 102**
"Design on Computer – A Coming of Age"

SESSION 6: COMPUTATIONAL BIO-ELECTROMAGNETICS **Parallel with Sessions 7 & 8)**
Chairs: Ray Luebbers and Susan Hagness

0920	"Numerical Investigation of Two Confocal Microwave Imaging Systems for Breast Tumor Detection"	Susan C. Hagness, Xu Li, Elise C. Fear & Maria A. Stuchly
0940	"FDTD Studies on SAR in Biological Cells Exposed to 837 and 1900 MHz in a TEM Cell"	A.W. Guy
1000	"Modelling of Personnel Electromagnetic Radiation Hazards Deliberation of a Novice"	Alan Nott
1020	**BREAK**	
1040	"Modeling the EMC Performance of Implanted Medical Devices"	David Ellingson & Eduardo Villaseca
1100	"Modeling Interference Between Very Low Frequency Electromagnetic Fields and Implanted Cardiac Pacemakers"	Trevor W. Dawson & Maria A. Stuchly
1120	"Using Computational Electromagnetics to Solve an Occupational Health and Safety Incident"	Timothy Priest, Kevin Goldsmith & Dean DuRieu
1140	"Analysis of Permanent Magnet Type of MRI Taking Account of Hysteresis and Eddy Current and Experimental Verification"	Norio Takahashi, Siti Zubaidah, Takeshi Kayano Koji Miyata & Ken Ohashi

SESSION 7: VIRTUAL REALITY IN REAL-WORLD APPLICATIONS **(Parallel with Sessions 6 & 8)**
Chairs: Stan Kubina and Dennis DeCarlo

0920	"A Virtual Radiation Pattern Range and Its Uses - C-130/Hercules HF Notch Antenna"	Stanley J. Kubina, Christopher W. Trueman David Gaudine
0940	"HF Towel-Bar Antenna Location Study Aboard an H3 Sikorsky Helicopter"	Saad N. Tabet, Carl D. Myers & Dennis DeCarlo
1000	"Improving Model Confidence through Metamorphosis"	Douglas R. Munn
1020	**BREAK**	
1040	"Model Morphing for Insight into the HF Assessment Parameters"	Douglas R. Munn
1100	"3D Modeling of Complex Helicopter Structures: Prediction and Measurements"	Anastasis C. Polycarpou, Dong-Ho Han Stavros V. Georgakopoulos & Constantine A. Balanis

WEDNESDAY MORNING 22 MARCH 2000

SESSION 7: VIRTUAL REALITY IN REAL-WORLD APPLICATIONS (cont)

1120	"Increasing the Productivity of NEC Analysis with Virtual Reality and 3D Laser Scanners"	Kevin J. Cybert & Daniel D. Reuster
1140	"An Interactive HTML Based Multimedia Course on Antennas"	Ulrich Türk & Peter Russer

SESSION 8: EMC **(Parallel with Sessions 6 & 7)**

Chairs: Bruce Archambeault and Jim Drewniak

0920	"Adding Imperfections to EMC FDTD Models as a Means of Increasing Accuracy"	Colin E. Brench
0940	"Power Conversion Techniques for Portable EMI Sensitive Applications"	Reinaldo Perez
1000	"Using the Partial Element Equivalent Circuit (PEEC) Simulation Technique to Properly Analyze Power/Ground Plane EMI Decoupling Performance"	Bruce Archambeault
1020	**BREAK**	
1040	"EMI Model Validation and Standard Challenge Problems"	Bruce Archambeault & James L. Drewniak
1100	"Modeling EMI Resulting from a Signal via Transition Through Power/Ground Layers"	Wei Cui, Xiaoning Ye, Bruce Archambeault Doug White, Min Li & James L. Drewniak
1120	"Techniques for Optimizing FEM/MoM Codes"	Y. Ji, T.H. Hubing, & H. Wang
1140	"Numerical Modeling of Shielding by a Wire Mesh Box"	Gerald J. Burke & David J. Steich

LUNCH

WEDNESDAY AFTERNOON

SESSION 9: PROPAGATION **(Parallel with Sessions 10 & 11)**

Chairs: Steve Fast and Frank Ryan

1320	"A Fast Quasi Three-Dimensional Propagation Model for Urban Microcells"	Joseph W. Schuster & Raymond J. Luebbers
1340	"FDTD Techniques for Evaluating the Accuracy of Ray-Tracing Propagation Models for Microcells"	Joseph W. Schuster & Raymond J. Luebbers
1400	"A Building Database Features Pre-Processor for 3-D SBR/GTD Urban EM Propagation Models"	James Pickelsimer & Raymond J. Luebbers
1420	"Toward a New Model for Indoor and Urban Propagation Using Percolation Theory"	G. Franceschetti, S. Marano, N. Pasquino, & I.M. Pinto
1440	"Ray Tracing Algorithm for Indoor Propagation"	C.W. Trueman, R. Paknys, J. Zhao, D. Davis, & B. Segal
1500	**BREAK**	
1520	"Modeling Large and Small-Scale Fading on the DPSK Datalink Channel Using a GTD Ray-Tracing Model"	Kent Chamberlin, Mikhailo Seledtsov & Petar Horvatic
1540	"Rough Surface Forward Scatter in the Parabolic Wave Equation Model"	Frank J. Ryan
1600	"A Comparison of Electromagnetic Parabolic Equation Propagation Models Used by the U.S. Navy to Predict Radar Performance"	Donald de Forest Boyer & Huong Pham

SESSION 10: WAVELET AND TLM MODELING TECHNIQUES **(Parallel with Sessions 9 & 11**

Chairs: Wolfgang J.R. Hoefer and Peter Russer

1320	"The Implementation of a High Level (1st-order) Haar Wavelet MRTD Scheme"	Enqiu Hu, Poman P.M. So, Masafumi Fujii, Wei Liu Wolfgang J. R. Hoefer
1340	"Multi-Resolution Based TLM Technique Using Haar Wavelets"	Ismael Barba, Jose Represa, Masafumi Fujii, Wolfgang J.R. Hoefer
1400	"Formulation and Study of an Arbitrary Order Haar Wavelet Based Multi-Resolution Time Domain Technique"	Costas D. Sarris & Linda P.B. Katehi

WEDNESDAY AFTERNOON 22 MARCH 2000

SESSION 10: WAVELET AND TLM MODELING TECHNIQUES (cont)

1420	"Computational Optimization of MRTD Haar-Based Adaptive Schemes Used for the Design of RF Packaging Structures"	Manos M. Tentzeris
1440	"Time-Domain Simulation of Electromagnetic Wave Propagation in a Magnetized Plasma"	J. Paul, C. Christopoulos & D.W.P. Thomas
1500	**BREAK**	
1520	"TLM Simulation of Patch Antenna on Magnetized Ferrite Substrate"	M.I. Sobhy, M.W. R. Ng, R.J. Langley & J.C. Batchelor
1540	"On the Practical Use of Layered Absorbers for the Simulation of Planar Microwave Circuits Using the SCN-TLM Method"	Jürgen Rebel, Tobias Mangold, Peter Russer
1600	"A Numerical Study of MEMS Capacitive Switches Using TLM"	Fabio Coccetti, Larissa Vietzorreck, Vitali Chtchekatourov, Peter Russer
1620	"Thin Wire Modeling with the TLMIE-Method"	S. Lindenmeier, C. Christopoulos & P. Russer
1640	"What Determines The Speed of Time-Discrete Algorithms"	Tobias Mangold, Jürgen Rebel, Wolfgang J.R. Hoefer, Poman P.M. So, & Peter Russer

SESSION 11: TIME DOMAIN METHODS AND APPLICATIONS **(Parallel with Sessions 9 & 10)**
Chairs: Amelia Rubio Bretones and R. Gomez Martin

1320	"Introducing a New Time-Domain Electromagnetic Field Solver LSFEM™TD-3D"	Craig C. Ouyang, B.N. Jiang & Nina Liao
1340	"Characteristic-Based Time-Domain Method for Antenna Analysis"	Dan Jiao, Jianming Jin & J.S. Shang
1400	'Modeling of Thin-Wire Structures by Solving the EFIE in Time Domain"	Friedrich Schunn & Hermann Singer
1420	"Time-Domain Analysis of Thin-Wire Loaded Antenna Using Integral Equations"	M. Fernandez Pantoja, A. Rubio Bretones R. Gomez Martin
1440	"Haar MRTD Wave Propagation Through Isotropic Plasmas"	Ismael Barba, Jose Represa, Masafumi Fujii, Wolfgang J. R. Hoefer
1500	**BREAK**	
1520	"Time-Domain Scattering from Arbitrarily Shaped Metallic Shelters with Apertures: Numerical and Experimental Analysis"	Giuliano Manara & Agostino Monorchio
1540	"Integral Equation Based Analysis of Transient Electromagnetic Scattering from Three Dimensional Inhomogeneous Dielectric Objects"	N.T. Gres, A.A. Ergin, B. Shanker, & E. Michielessen
1600	"Computational Properties of Wavelet Based PEEC Analysis in Time Domain"	G. Antonini & A. Orlandi
1620	"Time Domain Modeling of a Pulsed Horn-Dish Antenna"	M.J. Bluck, S.P. Walker & C. Thomas
1640	"Time-Domain Physical-Optics Simulation Technique for Electromagnetic Imaging by Subsurface Radar"	A. Boryssenko, V. Prokhorenko & V. Tarasuk

THURSDAY MORNING 23 MARCH 2000

0715 – 0800 **CONTINENTAL BREAKFAST**

0815 **PLENARY SPEAKER:** **W.C. Chew,** University of Illinois at Urbana-Champaign
"Fast Solvers for Electromagenetic Simulations – A New Age Analysis Tool"

SESSION 12: MOMENT METHODS **(Parallel with Sessions 13 & 14)**
Chairs: Zachi Baharav and Ramakrishna Janaswamy

0920	"Iterative Solvers for Dense Matrices –Applications to Moment Method Matrices"	Jürgen v. Hagen & Werner Wiesbeck
0940	"Convergence Properties of the CFIE for Several Conducting Scatterers"	William D. Wood, Jr., Kueichien C. Hill William J. Kent, Robert G. Layden & Lisa A. Cravens
1000	"Modeling of General Surface Junctions of Composite Objects in an SIE/MoM Formulation"	Joon Shin, Allen W. Glisson, & Ahmed A. Kishk
1020	**BREAK**	

THURSDAY MORNING 23 MARCH 2000

SESSION 12: MOMENT METHODS (cont

1040	"A Novel Grid-Robust Higher-Order Vector Basis Function for the Method of Moments"	G. Kang, J.M. Song, W.C. Chew, K. Donepudi, & J.M. Jin
1100	"Analytical Treatment of Green's Functions Singularities in Microstrip Structures"	E. Jiménez, F.J. Cabrera & J.G. Cuevas del Río
1120	"A Two-Stage Numerical Procedure for Extraction of Surface Wave Poles for Multilayered Media"	Ya-Xun Liu, Le-Wei Li, Tat-Soon Yeo, Pang-Shyan Kooi Mook-Seng Leong
1140	"Higher-Order Electromagnetic Modeling of Multilayer Microstrip Structures"	Feng Ling, Kalyan Donepudi & Jianming Jin

SESSION 13: CONFORMAL ANTENNAS **(Parallel with Sessions 12 & 14)**
Chairs: Leo Kempel and Douglas Werner

0920	"A Conformal, Flexible, Multifunction Communications Antenna"	T.R. Holzheimer
0940	"Finite Printed Antenna Array Modeling Using an Adaptive Multi-Resolution Approach"	Lars S. Andersen, Yunus E. Erdemli & John L. Volakis
1000	"A Technique for Analyzing Radiation from Conformal Antennas Mounted on Arbitrarily-Shaped Conducting Bodies"	Dean Arakaki, Douglas H. Werner & Raj Mittra
1020	**BREAK**	
1040	"Using Computational Electromagnetics and Monte-Carlo Methods to Locate Antennas on Aircraft"	Kevin Goldsmith, Paul Johnson & Timothy Priest
1100	"Coupling Phenomena in Horizontal and Vertical Polarized Aperture Coupled Patch Antennas on Cylindrical Surfaces"	D. Löffler, J. von Hagen & W. Wiesbeck
1120	"Modeling and Analysis of Wideband Conformal Antennas"	Keith D. Trott, Rene D. Guidry & Leo C. Kempel
1140	"Curvature Effects on a Conformal Log-Periodic Antenna"	Charles Macon, Leo Kempel, Keith Trott, Stephen Schneider

SESSION 14: ANTENNA ARRAYS **(Parallel with Sessions 12 & 13)**
Chairs: Keith Lysiak and Nathan Cohen

0920	"Problems of Characterising Array Manifolds for Naval Platforms in HF Environments"	Linda Holtby
0940	"Designing a VHF Wrap-Around DF Antenna Array Using NEC"	Keith Lysiak
1000	"Specifying a Direction Finding Antenna with Examples"	T. R. Holzheimer
1020	**BREAK**	
1040	"A High Efficiency Broad Band Wire Antenna System"	Kevin J. Cybert & Daniel D. Reuster
1100	"Comparison of Calculations and Measurements of an Electronically Scanned Circular Array"	James M. Stamm, Michael W. Jacobs & James K. Breakall
1120	"Array Sidelobe Reduction by Small Position Offsets of Fractal Elements"	Nathan Cohen & Robert G. Hohlfeld
1140	"The Radiation Characteristics of Recursively Generated Self-Scalable and Self-Similar Arrays"	D.H. Werner & P.L. Werner

THURSDAY AFTERNOON

SESSION 15: FAST AND EFFICIENT METHODS **(Parallel with Sessions 16 & 17)**
Chairs: Weng C. Chew and Jiming Song

1320	"Three Dimensional Scattering Analysis in Stratified Medium Using Fast Inhomogeneous Plane Wave Algorithm"	Bin Hu, & Weng Cho Chew
1340	"Multilevel Fast Multipole Algorithm for Analysis of Large-Scale Microstrip Structures"	Feng Ling, Jiming Song & Jianming Jin
1400	"A Novel Implementation of Multilevel Fast Multipole Algorithm for High-Order Galerkin's Method"	K.C. Konepudi, J.M. Song, J.M. Jin, G Kang & W.C. Chew
1420	"Incomplete LU Preconditioner for FMM Implementation"	Kubilay Sertel, & John L. Volakis

THURSDAY AFTERNOON 23 MARCH 2000

SESSION 15: FAST AND EFFICIENT METHODS (cont)

1440	"A Fast, High-Order Scattering Code for Solving Practical RCS Problems"	J.J. Ottusch, J.L. Visher & S.M. Wandzura
1500	**BREAK**	
1520	"An Efficient Integral Equation Based Solution Method for Simulation of Electromagnetic Fields in Inhomogeneous Dielectric (Biological) Media"	E. Bleszynski, M. Bleszynski & T. Jaroszewicz
1540	"Efficient Solution of Large-Scale Electromagnetic Eigenvalue Problems Using the Implicitly Restarted Arnoldi Method"	Daniel White & Joseph Koning
1600	"Fast Fourier Transform of Functions with Jump Discontinuities"	Guo-Xin Fan, & Qing Huo Liu
1620	"Applications of Non-Uniform Fast Transform Algorithms in Numerical Solutions of Integral Equations"	Q.H. Liu, X.M. Xu, & Z.Q. Zhang

SESSION 16: APPLICATIONS OF THE FDTD TECHNIQUE **(Parallel with Sessions 15 & 17)**
Chairs: Atef Elsherbeni and Wenhua Yu

1320	"A Non-Dissipative Staggered Fourth-Order Accurate Explicit Finite Difference Scheme for the Time-Domain Maxwell's Equations"	A. Yefet & P.G. Petropoulos
1340	"FDTD Method for Maxwell's Equation in Complex Geometries"	A. Ditkowski, K. Dridi & J.S. Hesthaven
1400	"FDTD Analysis of Tapered Meander Line Antennas for RF and Wireless Communications"	Chun-Wen Paul Huang, Atef Z. Elsherbeni Charles E. Smith
1420	"FDTD Modeling of an Electron Cyclotron Resonance Reactor Driven by an Lisitano Coil"	Gaetano Marrocco, Fernando Baardati Francesco De Marco
1440	"Modeling Microwave and Hybrid Heating Using FDTD"	J. Haala & W. Wiesbeck
1500	**BREAK**	
1520	"A Conformal Finite Difference Time Domain (CFDTD) Algorithm for Modeling Perfectly Conducting Objects"	Wenhua Yu, Raj Mittra, Dean Arakaki, & Doug Werner
1620	"A Finite-Difference Algorithm for Modeling of Conductive Wedges in 2D"	Piotr Przybyszewski
1640	"Advanced Techniques of Geometrical Modelling and CFDTD"	F. Rivas, J.P. Roa & M.F. Cátedra

SESSION 17: HYBRID TECHNIQUES **(Parallel with Sessions 15 & 16)**
Chairs: Agostino Monorchio and P. H. Pathak

1320	"A Three-Dimensional Hybrid Technique for Combining the Finite Element and Finite Difference Method in Time Domain'	Agostino Monorchio & Raj Mittra
1340	"Vertical Antenna Near-Field Computation in Complex Environments by a Hybrid Method"	F. Bardati, E. Di Giampaolo, A. Durantini, & G. Marrocco
1400	"3D EM Problem Modeling by Geometry Decomposition and Combination of the FE, FDTD and BIE Techniques"	Hendrik Rogier, Daniël De Zutter & Frank Olyslager
1420	'Hybrid FDTD-Frequency Dependent Network Simulations Using Digital Filtering Techniques"	Ian Rumsey & Melinda Piket-May
1440	"Study of Electrically-Short Thin-Wire Antennas Located in the Proximity of Inhomogeneous Scatterers Using a Hybrid NEC/FDTD Approach"	A. Rubio Bretones, R. Mittra & R. Gómez Martin
1500	**BREAK**	
1520	"A Review of Some Hybrid High Frequency and Numerical Solutions for Radiation/Scattering Problems"	P.H. Pathak & R.J. Burkholder
1540	"An Hybrid Method Combining Integral Equations and Modal Expansion Applied to the RCS Modulation of Antennas and Rotating Fans"	Andre Barka & Paul Soudais
1600	"A 2D TLM and Haar MRTD Real-Time Hybrid Connection Technique"	Masafumi Fujii, Poman P.M. So, Enqiu Hu, Wei Liu Wolfgang J. R. Hoefer

END OF TECHNICAL PAPERS

FRIDAY 24 MARCH 2000

0700 – 0730	**CONTINENTAL BREAKFAST** (For Short Course and hands-on-workshop attendees only)	**Glasgow Courtyard**
0730 – 0820	**SHORT COURSE/HANDS-ON-WORKSHOP REGISTRATION**	**Glasgow 103**
0830-1630	**SHORT COURSE #9 (Full Day)** Why is There Electromagnetic Radiation and Where Does It Come From?" John Shaeffer, Marietta Scientific Inc and Edmund K. Miller, Santa Fe, NM.	
0830-1630	**SHORT COURSE #10 (FULL-DAY)** "Recent Advances in Fast Algorithms for Computational Electromagnetics" Weng Cho Chew, Jianming Jin, Eric Michielssen and Jiming Song, University of Illinois at Urbana-Champaign	
0830-1630	**HANDS-ON-WORKSHOP #11 (FULL-DAY)** "Method of Moments (MoM) Using MATHCAD" Jovan Lebaric, Naval Postgraduate School	
0830-1630	**SHORT COURSE #12 (HALF-DAY, MORNING)** "Computational Electromagnetics using Beowulf-Cluster Computers" Tom Cwik and Daniel S. Katz, Jet Propulsion Laboratory	
1330-1630	**SHORT COURSE #13 (HALF-DAY, AFTERNOON)** "Multiresolution FEM: Introduction and Antenna Applications" John L. Volakis, University of Michigan, and Lars Andersen, Agilent	

PLEASE NOTE THAT A 10% DISCOUNT IS IN EFFECT FOR ALL WORKSHOPS TAKEN AFTER ATTENDING AN INITIAL WORKSHOP. THIS APPLIES TO THE GROUP OF WORKSHOPS FOR MATLAB AND MATHCAD.

SATURDAY 25 MARCH 2000

0700 – 0730	**CONTINENTAL BREAKFAST** (For Short Course and hands-on-workshop attendees only)	**Glasgow Courtyard**
0730 – 0820	**SHORT COURSE/HANDS-ON-WORKSHOP REGISTRATION**	**Glasgow 103**
0830-1630	**HANDS-ON-WORKSHOP #14 (FULL-DAY)** "FD/FDTD Using MATLAB" Jovan Lebaric, Naval Postgraduate School	
0830-1630	**SHORT COURSE #15 (FULL-DAY)** "An Introduction to Radar Cross Section" John Shaeffer, Marietta Scientific, Inc.	

REGISTRATION/SHORT COURSES/HANDS-ON-WORKSHOPS

THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY
16TH ANNUAL REVIEW OF PROGRESS IN APPLIED COMPUTATIONAL ELECTROMAGNETICS
March 20 - 25, 2000 -- Naval Postgraduate School, Monterey, CA

I. Conference Registration

Please print (Black ink) (Note: Conference Registration fee does not include ACES Membership Fee or Short Course Fee)

Last Name | First Name | Middle Initial

Mailing Address | Company/Organization/University | Department/Mail Station

City/Code | Provinces/State | Country | Zip/Postal Code

Telephone | Fax | E-mail | Amateur Radio Call Sign

	BEFORE 3/1/2000	3/1 TO 3/13/2000	After 3/13/2000
ACES CURRENT MEMBER	❑ $300	❑ $315	❑ $330
NON-MEMBER	❑ $350	❑ $365	❑ $380
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 '2000 Short Courses and Hands-on-Workshops Registration

		BEFORE 3/1/00	3/1/ TO 3/13/00	AFTER 3/13/00
1.	Computational Electromagnetic Methods in Mobile Wireless Communications Design (Full-Day) Monday, March 20 R. Perez	❑ $160	❑ $175	❑ $190
2.	XML and Modern Internet Technologies for Scientific Applications (Full day) Monday, March 20, F.S. Khan	❑ $160	❑ $175	❑ $190
3.	The Basics of the Finite Difference Time Domain Technique for Electromagnetic Applications (Full Day) Monday March 20, A. Elsherbeni and A. Glisson	❑ $160	❑ $175	❑ $190
4.	Techniques for Electromagnetic Visualization (Full-Day) Monday, March 20, E.K. Miller and J. Shaeffer	❑ $160	❑ $175	❑ $190
5.	EIGER – Electromagnetic Interactions Generalized: An introduction to and tutorial on the software suite (Full-Day) Monday, March 20, R. Sharpe, N. Champagne, W. Johnson, D. Wilton, and J.B. Grant	❑ $160	❑ $175	❑ $190
6.	MATHCAD Basics (Half-Day Morning) Monday, March 20 **Hands-on Workshop**, J. Lebaric	❑ $120	❑ $135	❑ $150
7.	MATLAB Basics (Half-Day afternoon) Monday, March 20 **Hands-on Workshop**, J. Lebaric	❑ $120	❑ $135	❑ $150
8.	EMI/EMC Computational Modeling for Real-World Engineering Problems (Full Day) Monday, March 20, O. Ramahi and B. Archambeault.	❑ $160	❑ $175	❑ $190

9. Why is there Electromagnetic Radiation and Where Does it Come From? (Full-Day) Friday, March 24, J. Shaeffer, and E.K. Miller	❑	$160	❑	$175	❑	$190
10. Recent Advances in Fast Algorithms for Computational Electromagnetics. (Full Day) Friday, March 24 W.C. Chew, J. Jin, E. Michielssen and J. Song	❑	$160	❑	$175	❑	$190
11. Method of Moments (MoM) using MATHCAD (Full Day) Friday, March 24, **Hands-on Workshop**, J. Lebaric.	❑	$235	❑	$250	❑	$265
12. Computational Electromagnetics using Beowulf-Cluster Computers (Half-Day morning) Friday March 24, T. Cwik and D.Katz	❑	$100	❑	$115	❑	$130
13. Multiresolution FEM: Introduction and Antenna Applications (Half-Day afternoon) Friday, March 24, J. L. Volakis and L. Andersen	❑	$100	❑	$115	❑	$130
14. FD/FDTD using MATLAB (Full Day) Saturday, March 25, **Hands-on Workshop**, J. Lebaric.	❑	$235	❑	$250	❑	$265
15. An Introduction to Radar Cross (Full Day) Saturday, March 25, J. Shaeffer.	❑	$160	❑	$175	❑	$190

Total for Section II - __________

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SHORT COURSES/HANDS-ON-WORKSHOPS

MONDAY, 20 March 2000

1. Computational Electromagnetic Methods in Mobile Wireless Communications Design (Full-Day)

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) to 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) to 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, 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

2. XML and Modern Internet Technologies for Scientific Applications (Full-Day)

Furrukh S. Khan, Ohio State University

The eXtensible Markup Language (XML) is fast becoming a standard way to define and exchange "intelligent" data between applications, and is currently gaining a lot of attention from the scientific community. Adopting XML to scientific applications can have far reaching benefits. Even though XML is particularly appealing for Internet applications, it is equally useful in other environments, as a means of achieving uniform and standardized exchange of data between applications. This course is designed for both the beginning and intermediate level audience. It will lead the audience, step by step, from fundamental concepts, to the actual writing of application code. It is expected, that after taking this course the audience will be prepared to use XML in applications written in Java, C, C++, CORBA, or JavaScript, and be able to display XML documents in standard browsers.

The course will start with an introduction to XML and related modern Internet technologies, such as, the DTD (Data Type Description), the XSL (eXtensible Style Sheet Language), three tier architectures, Servlets, XML enabled browsers, and XML parsers. The Document Object Model will be covered, along with accessing information in XML documents in a standard way through Java, CORBA and JavaScript. Non standardized C++ parsers for XML will also be covered. Displaying XML documents in browsers using the XSL and JavaScript will be introduced. These concepts will be reinforced by example code. The benefits of using XML in scientific applications will be emphasized, along with methods to incorporate binary files in XML. Examples of describing electromagnetics grid data (stored in binary files) in XML will be given. The slides of this course, along with all the supporting PDF documents, will become available on line at http://eewww.eng.ohio-state.edu/~khan/ about two weeks before the course date.

SHORT COURSES/HANDS-ON-WORKSHOPS

MONDAY, 20 MARCH 2000

3. The Basics of The Finite Difference Time Domain Technique for Electromagnetic Applications (Full-Day), 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, 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, crosstalk in digital circuits, and biological effects of handheld communication antennas. The attendee will receive 1D and 2D working codes with a graphical user interface.

4. Techniques for Electromagnetic Visualization (Full-Day)
Edmund K. Miller, Santa Fe, NM, John Shaeffer, Marietta Scientific, Inc.

As the exponential growth of computational power continues, we increasingly need visualization in electromagnetics (EM): to validate the input geometries; to validate that indeed a reasonable solution was computed; to increase our understanding of the detailed physical mechanisms responsible for system behavior which then enables us to optimize our designs; and to move our EM teaching paradigm from one that is mathematical based to one that is physical-mechanism based.

Visualization in EM computations serves at least two distinct purposes: 1) to display a problem's physical characteristics, and its corresponding numerical representation or model; and 2) to display EM quantities associated with that model. In either case, the resulting visual display provides a more understandable and interpretable way for the user to access the underlying numerical data, vastly increasing the bandwidth of that interaction.

This short course will address visual EM from two perspectives sharing the common goal of presenting participants with a variety of alternatives for visually displaying EM data. The emphasis will be on the benefits of visualization from the viewpoint of its practical utility, e.g., in identifying numerical errors and improving physical understanding. One perspective will be to consider the choices available to visualize data in general, and EM data in particular. Such aspects as the rather limited variety of display variables that are available for visualization, the need to select formats that retain data fidelity, and use of color, will be discussed.

The other perspective will be to consider the EM choices that affect the visualization, such as displaying time-average vs. instantaneous quantities, surface sources and near fields, and far-fields. Scalar-vs.-vector displays will be examined as well as the power of interactive viewing, model overlays, multi plots and AVI files. Finally, computer-implementation issues will be discussed, such as using C++ or Fortran, MFC and OpenGL.

SHORT COURSES/HANDS-ON-WORKSHOPS

MONDAY, 20 MARCH 2000

5. EIGER* – Electromagnetic Interactions Generalized: An introduction to and tutorial on the software suite (Full-Day)

Robert M. Sharpe and Nathan J. Champagne, Lawrence Livermore National Laboratory
William A. Johnson, Sandia National Laboratories; Donald R. Wilton, University of Houston; and J. Brian Grant, *ANT-S*

EIGER (Electromagnetic Interactions GEneRalized) is a single integrated software tool suite that allows a variety of numerical and analytical methods to be applied simultaneously to complex problems in a completely self-consistent manner. The software suite employs moment and/or finite element solutions for radiation and scattering of two- and three-dimensional geometries. In addition, a variety of Green's Functions are available for modeling layered media and periodic structures.

The code suite consists of a graphical pre-processor, core physics engines, and a visual post-processor. The physics components of the code suite have been developed to run seamlessly on a full range of platforms from Intel-based PCs, to Unix based workstations, to massively parallel systems.

The course will provide an overview of the numerical formulations employed in EIGER, and a summary of the key concepts used in the software suite. In addition, tutorials and examples demonstrating the flexibility and capability of the packages will be presented.

*Note that the EIGER software suite is currently limited to government use (including use on government contracts).

6. Hands-on Workshop: MATHCAD Basics (Half-Day, morning)
Jovan Lebaric, Naval Postgraduate School

This workshop will serve as an introduction for Short Course #11. Topics will include an introduction to MATHCAD syntax, text and formula editing, numeric and symbolic calculations, and visualization and animation.

7. Hands-on Workshop: MATLAB Basics (Half-Day, afternoon)
Jovan Lebaric, Naval Postgraduate School

This workshop will serve as an introduction for Short Course #14. Topics will include an introduction to MATLAB syntax, matrix/vector/element-by-element operations, code vectorization and memory usage tradeoffs, and graphics and GUI.

8. EMI/EMC Computational Modeling for Real-World Engineering Problems (Full-Day)
Omar Ramahi, Compaq Corporation, 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.

SHORT COURSES/HANDS-ON-WORKSHOPS

MONDAY, 20 MARCH 2000

8. EMI/EMC Computational Modeling for Real-World Engineering Problems (cont)

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. This will be followed by an assessment of the popular commercial tools available today. We conclude this course with a discussion of model validation techniques and present standard modeling problems that allow engineers to evaluate commercial software packages.

FRIDAY, 24 MARCH 2000

9. Why is there electromagnetic Radiation and Where Does it come from?

John Shaeffer, Marietta Scientific Inc, and Edmund K. Miller, Santa Fe, NM.

"Why is there electromagnetic (EM) radiation and where does it come from?" is a simple question. While we know the mathematical answer, we seldom understand the physical-mechanism answer. And it is the Physical-mechanism answer that is crucial to the design, let alone optimization, of antennas or scatterers. Important questions for such applications are the concepts of radiation centers for antennas in pattern optimization or scattering centers for controlling radar cross section.

Among the topics covered in this short course will be summarizing available relevant data and observations as well as to offer possibly new perspectives concerning radiation physics using two different approaches for developing radiation images. One is FARS (Far-field Analysis of Radiation Sources), an "imaging" procedure for using bistatic far fields from solved-for boundary sources and known geometries to quantitatively allocate the spatial distribution of Em power coming from an object. FARS is easily implemented using standard far-field computations, and has been applied in both the time and frequency domains for which a variety of examples will be shown.

FRIDAY, 24 MARCH 2000

9. Why is there electromagnetic Radiation and Where Does it come from? (cont)

The other approach to be discussed is bistatic k-Space imaging, an analytical technique based on a Fourier transform that produces a radiation/scattering-center image without the need for the usual ISAR frequency sweep. It is applicable to both antenna and to radar-cross-section problems, also requiring only knowledge of the current distribution and object geometry. The motivation and history of K-space Imaging will be discussed, followed by a description of the image coordinate system, its computation in k-space from the generalized radiation integral, and the role of the field sampling on the spatial resolution that is obtained. Examples of k-space images for both scatters and antennas will be shown, as well as a comparison of images obtained from analytical and experimental data. A FORTRAN subroutine listing for implementing the technique will be included. Our goal will be to give short-course participants new ways to think about radiation as well as quantitative tools that they can apply to their own problems.

10. Recent Advances in Fast Algorithms for Computational Electromagnetics (Full-Day)
Weng Cho Chew, Jianming Jin, Eric Michielssen, and Jiming Song
University of Illinois at Urbana-Champaign

This short course will cover recent advances in the development of fast algorithms for computational electromagnetics developed at the Center for Computational Electromagnetics at the University of Illinois. Topics include:

1. Overview of the fast algorithms in computational electromagnetics, fast iterative solvers;
2. Multilevel fast multipole algorithm (MLFMA);
3. Multilevel matrix decomposition method;
4. Steepest-descent path fast multipole method, thin-stratified media fast multipole algorithm;
5. Multilevel plane-wave time domain algorithm, applied to linear and nonlinear devices;
6. MLFMA combined with finite-element method, higher-order method;
7. The adaptive integral method for large microstrip structures;
8. Low-frequency MLFMA, low-frequency MOM;
9. Fast algorithms involving layered media;
10. Applications to scattering and radiation problems.

11. Hands-On Workshop: Method of Moments (MoM) using MATHCAD (Full-Day)
Jovan Lebaric, Naval Postgraduate School

This hands-on workshop will cover the following topics:

1. Method of Moments (MoM) for Electrostatics using MATHCAD
   Superposition, Green's Function Integrals, Potential and Field Visualization
   Examples: Wire at Known Potential, Microstrip
2. MOM for Radiation and Scattering for Wire Grid Models using MATHCAD
   Mixed Potential Formulation, Wire Junction Conditions, Green's
   Function Integrals, Far Field Visualization
   Examples: Radiation and Scattering for a Wire Dipole, Radiation for a Two Element Yagi
   Antenna, Eigen-spectrum and Eigen-modes for a Wire Dipole, Eigen-spectrum and
   Eigen-modes for a "Stick", Aircraft Model

FRIDAY, 24 MARCH 2000

12. Computational Electromagnetics using Beowulf-Cluster Computers (Half-Day, morning)

Tom Cwik and Daniel S. Katz
Jet Propulsion Laboratory

Over the last five years the use of commodity cluster supercomputing systems has grown in a variety of application areas. These machines consist of standard desktop computers interconnected through commodity network switches and software. Due to the internet explosion, the performance of network switches has advanced such that ensembles of two to tens or hundreds of PCs can be easily interconnected to form a powerful computer at an average cost of $2000 per node. This price includes all up-front costs for the hardware and software, and can vary depending on the amount of memory and processor being used. At the research-end, machines with thousands of nodes have been built and are being operated mainly at national laboratories. This computing power and available memory is becoming an enabling asset in high-fidelity electromagnetic engineering simulations at a cost that is low enough to be reasonable to many companies, university departments and research laboratories. Indeed, the continued evolution of processor computational power and networking hardware will enable highly powerful computer systems at a fraction of the cost of traditional high-end machines.

This tutorial will step through the process of using Beowulf-class cluster computers for a range of electromagnetic simulations. We will first describe the purchase and assembly of the hardware and software involved in current computer systems. Vendors that supply systems will also be identified. The various libraries, compilers and other system software will similarly be described as well as the necessary expertise in maintaining the system. Next we will examine a range of applications that have been ported to cluster computers, identifying issues in parallelization and performance. These applications will include a physical optics antenna design code, finite difference time domain codes for scattering, finite element codes for antenna and scattering analysis, frequency selective surface design codes and genetic algorithm optimization packages. The performance of these codes relative to known computer platforms will be shown, thereby revealing the improvements in turn-around time that can be expected in using these machines. We will conclude with an examination of the state-of-the-art in cluster machines, and what can be expected over the next one or two generations, a time span of two to three years.

SHORT COURSES/HANDS-ON-WORKSHOPS

FRIDAY, 24 MARCH 2000

13. Multiresolution FEM: Introduction and Antenna Applications (Half-Day, afternoon)
John L. Volakis, University of Michigan, Lars Andersen, Agilent

This course is a basic introduction to the finite element methods and its application to high frequency electromagnetics. The finite element method is one of the most popular techniques for numerical analysis in engineering. In electromagnetics, its application to propagation, microwave circuits, antennas and scattering is widespread. Recent developments on higher order, hierarchical or multiresolution elements have had a significant impact on the method's efficiency and accuracy for antenna modeling.

In this half-day course, we will go though a step by step development of the finite element method and related basis functions for two dimensions. Both, lower order and multi-resolution basis will be covered. Also, hybridizations of the finite element method with boundary and fast integral methods (fast multipole and adaptive integral methods) will be introduced. Three dimensional applications to arrays, frequency selective surfaces as well as printed and broadband antennas will be presented using multi-resolution elements.

SATURDAY, 25 MARCH 2000

14. Hands-On Workshop: FD/FDTD using MATLAB (Full-Day)
Jovan Lebaric, Naval Postgraduate School

This hands-on workshop will cover the following topics:

1. Finite Differences (FD) for Electrostatics and Magnetostatics
   Finite Integral (FIT) and Finite Difference (FD) formulations for Potentials
   Transparent Grid Termination (TGT) in Statics
   Potential and Field Visualization
   Example: Dielectric Substrate Microstrip
2. Finite Differences in Time Domain (1-D)
   Finite Integral Formulation
   Source Implementation
   Transparent Grid Termination
   Field Visualization
   Examples: TEM Transmission Line and Bounce Diagram Visualization
   Reflection and Transmission for a Dielectric Slab
3. Finite Differences in Time Domain (2-D)
   Finite Integral Formulation
   Source and Incident Field Implementation
   Transparent Grid Termination
   Field Visualization
   Examples: Line Source in Vicinity of a PEC Rod
   Scattering for a PEC Rod

SHORT COURSES/HANDS-ON-WORKSHOPS

SATURDAY, 25 MARCH 2000

15. An Introduction to Radar Cross Section (Full-Day)

John Shaeffer
Marietta Scientific, Inc.

Radar cross section is a topic that has had much publicity in the last decade and has been under development for over thirty years. RCS control is now a standard design discipline, however, it is a topic that is often shrouded in mystery and poorly understood.

The course will start with "Understanding Stealth -- A Layman's Description" and will then proceed to selected topics from the book *Radar Cross Section* by Knott, Shaeffer, and Tuley. This is an introductory course with emphasis on physical principles rather than mathematical detail.

Tentative outline: Understanding stealth – a layman's description - Radar Fundamentals
Definition of RCS
    Bistatic, Monostatic, Polarization scattering matrix
Scattering Mechanisms:
    Specular - Multi-bounce - Corners, cavities
End Region Side Lobes
    Edge Diffraction - Surface Wave Phenomena - Edge, Traveling and Creeping Waves
    Gaps and Cracks
Materials
    Specular - Non-Specular
Measurements
    Outdoor and Indoor ranges
RCS Data Formats
Scaling issues
Hip Pocket Formulas

MOTELS / HOTEL LIST FOR MARCH 2000 ACES SYMPOSIUM

20-25 MARCH 2000

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

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STAGECOACH MOTEL (**) (1 Star)
1111 10th St. Monterey, CA 93940
Phone: (831) 373-3632 FAX: (831)-648-1734
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MONTEREY BAY LODGE (**) (2 Star)
55 Camino Aguajito, Monterey, CA 93940
Phone: (831) 372-8057 FAX:(831) 655-2933
Rates: **Govt**. $41.65.**Conf**. $67.15 + tax
most rates apply for Mon thru Thursday

MONTEREY HILTON (**) (3 Star)
1000 Aguajito Rd. Monterey, CA 93940
(831) 373-6141 FAX: (831)375-2367
Rates: **Govt**. $94- 104.---**Conf**.$110-129 + tax

HYATT HOTEL & RESORT (**) (4 Star)
1 Old Golf Course Rd. Monterey, CA 93940
Phone: (831) 372-1234 FAX: (831)-375-6985
Rates: **Govt**. $71.- 146; **Conf**. $159-184 + tax

SUPER 8 MOTEL (2 Star)
2050 Fremont St. Monterey, CA. 93940
Phone: (831) 373-3081 FAX: (831) 372-6730
Rates: **Govt**. $49-Mon-Thurs, -$59 Fri-Sat-1bed
Conf. $59 Mon-Thurs; $69 Fri-Sat 2 bed + tax

(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, PAYS TAX.

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 gate to the Conference Registration location. IT MAY NOT BE OPEN DURING CONFERENCE DUE TO INCREASED SECURITY. The Ninth Street gate is always open.

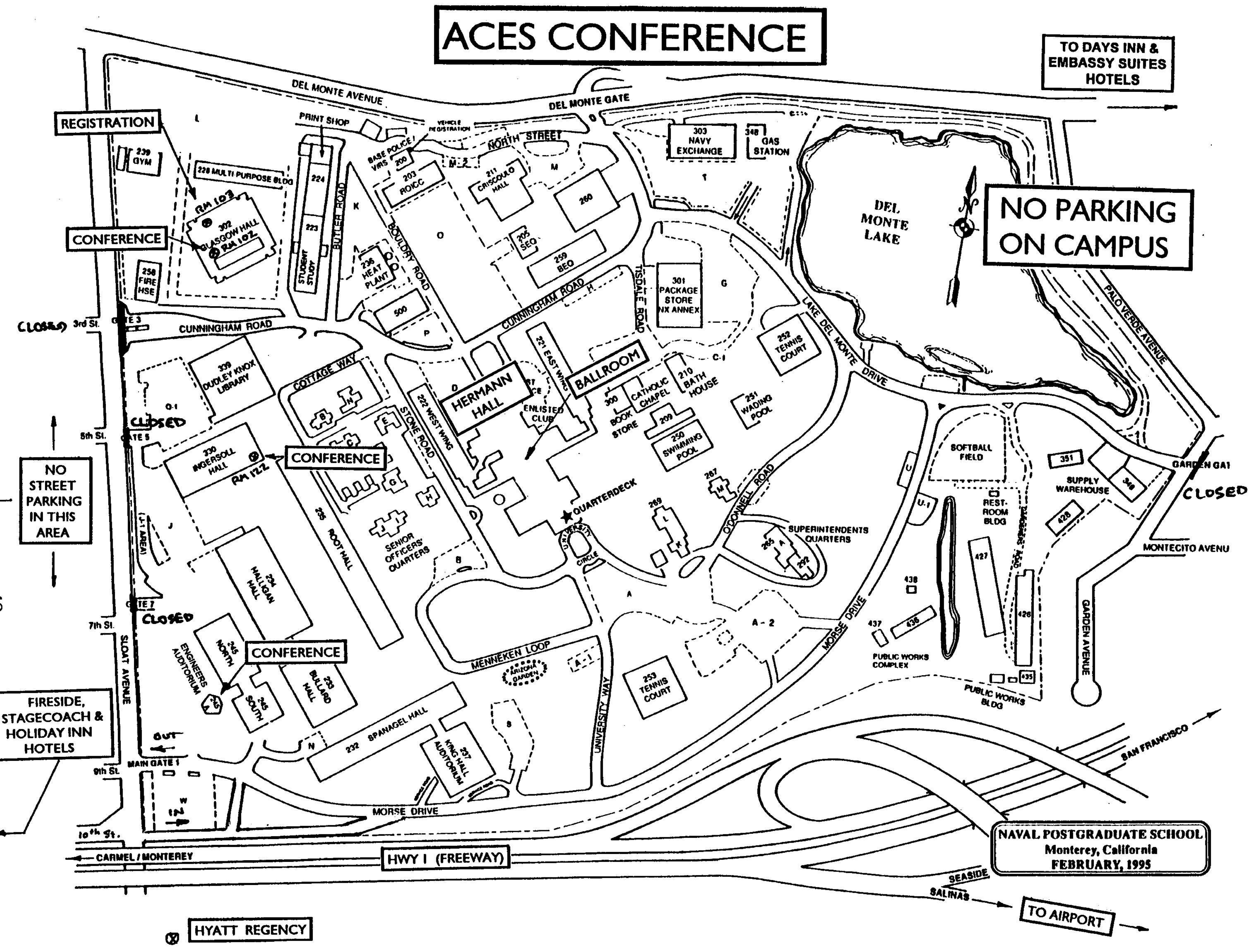
AIRLINE INFORMATION

The following airlines make connections from Los Angeles and San Francisco, CA. to Monterey, CA: American & United. Delta/Sky West serves from SFO only and US Air/Express serves from LAX only. There is no airline connection directly from San Jose, CA to Monterey, CA. You can fly to San Jose, but then you must rent a car.

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.



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BUTLER ROAD
BOULDRY ROAD
236 HEAT PLANT
500
BASE POLICE / VIRS 200
203 ROICC
VEHICLE REGISTRATION
NORTH STREET
211 CRISCOULO HALL
205 SEO
259 BEQ
260
DEL MONTE AVENUE
DEL MONTE GATE
303 NAVY EXCHANGE
348 GAS STATION
DEL MONTE LAKE
PALO VERDE AVENUE
CUNNINGHAM ROAD
TISDALE ROAD
301 PACKAGE STORE NX ANNEX
252 TENNIS COURT
LAKE DEL MONTE DRIVE
339 DUDLEY KNOX LIBRARY
COTTAGE WAY
HERMANN HALL
BALLROOM
221 EAST WING
222 WEST WING
ENLISTED CLUB
300 BOOK STORE
CATHOLIC CHAPEL
210 BATH HOUSE
209
250 SWIMMING POOL
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ARIZONA GARDEN
UNIVERSITY WAY
253 TENNIS COURT
232 SPANAGEL HALL
237 KING HALL AUDITORIUM
(J-1 AREA)
SLOAT AVENUE
CLOSED 3rd St. GATE 3
5th St. GATE 5 CLOSED
7th St. GATE 7 CLOSED
9th St. MAIN GATE 1
OUT
IN
10th St.
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CALL FOR PAPERS

THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

ANNOUNCES A SPECIAL ISSUE OF THE ACES JOURNAL ON

COMPUTATIONAL ELECTROMAGNETIC TECHNIQUES IN MOBILE WIRELESS COMMUNICATIONS

The Applied Computational Electromagnetics Society is pleased to announce the publication of a Special Issue of the ACES Journal on the role that computational electromagnetics plays in the design and analysis of wireless communications components, subsystems, and systems. The complexity of present wireless mobile architectures and the future complexities of wideband wireless mobile systems has sparked an interest in computational electromagnetics (CEM) as one of the many tools needed for the design of third generation mobile wireless communications systems. The purpose of this special issue is to draw analysts, designers, and management from both industry and academia to outline their ideas and research on the role of CEM in present or future wireless designs. Applications oriented papers are highly encouraged.

SUGGESTED TOPICS

Applications of computational electromagnetic techniques on any of the following:

- Smart and adaptive antennas
- PCS, Mobile, Gateways, Satellite antennas
- Propagation Models
- Atmospheric Models
- Systems design
- Correlation of measurement techniques and models
- Electromagnetic Interference
- Bioelectromagnetics
- LEO, MEO, Satellites Communications
- Digital/Analog components design
- RF components design

DEADLINE FOR PAPERS IS MARCH 28, 2000

Expected Publication Date is Fall 2000 Issue of ACES Journal

Please submit 4 copies of papers to either of the Guest Editors listed below. The review process will commence as papers are received. Notification of accepted papers will be made immediately as papers are reviewed.

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CALL FOR PAPERS

THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

ANNOUNCES A SPECIAL ISSUE OF THE ACES JOURNAL ON

COMPUTATIONAL BIOELECTROMAGNETICS

The Applied Computational Electromagnetics Society is pleased to announce the publication of a Special Issue of the ACES Journal on applications and advances in methods and applications in computational bioelectromagnetics. The objectives of this special issue are to present advances in computational techniques, reviews and/or comparisons of methods, and applications of computational bioelectromagnetics. Prospective authors are encouraged to submit papers of archival value that address these objectives and other suggested topics listed below.

SUGGESTED TOPICS

- Applications of computational bioelectromagnetics
  - Cellular telephone analysis, design, etc.
  - Medical imaging
  - EM Safety analysis
  - Etc.
- Methods used for computational bioelectromagnetics
  - Finite-difference time-domain
  - Finite element method
  - Other methods
- Models for computational bioelectromagnetics
  - High resolution human body models
  - Electrical properties of human tissue
- Comparisons of methods, models, or techniques

DEADLINE FOR PAPERS IS AUGUST 25, 2000

Potential contributors wishing to discuss the suitability of their contribution to the special issue may contact one of the following three Guest Editors by email or phone:

Cynthia Furse	furse@ece.usu.edu	**Tel: (435) 797-2870**
Susan Hagness	hagness@engr.wisc.edu	**Tel: (608) 265-5739**
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All submissions for this special issue should be addressed to:

Cynthia Furse -- Special Issue on Bioelectromagnetics
Dept. of Electrical and Computer Engineering
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