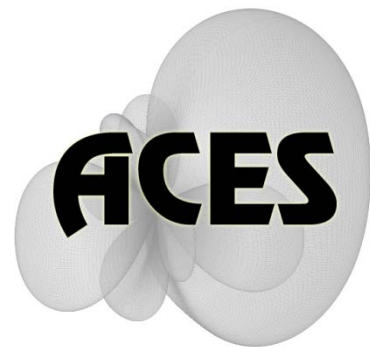


# Applied Computational Electromagnetics Society

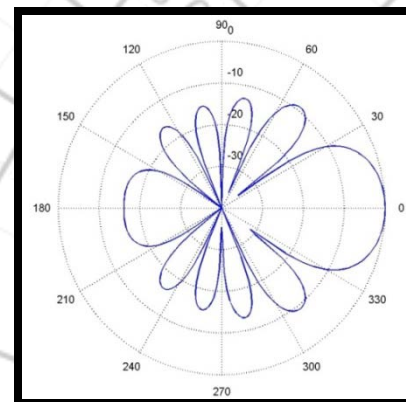
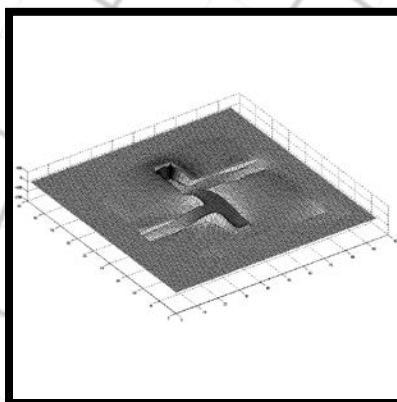
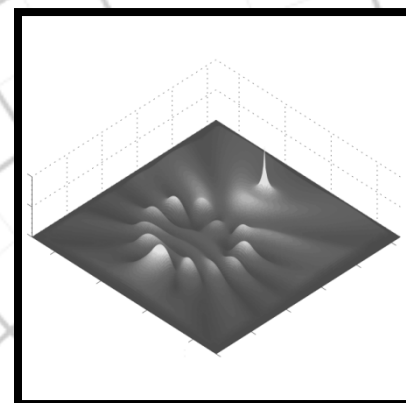
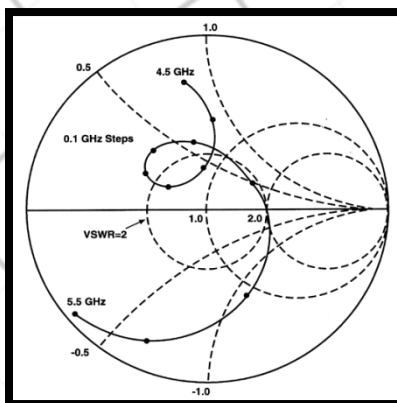
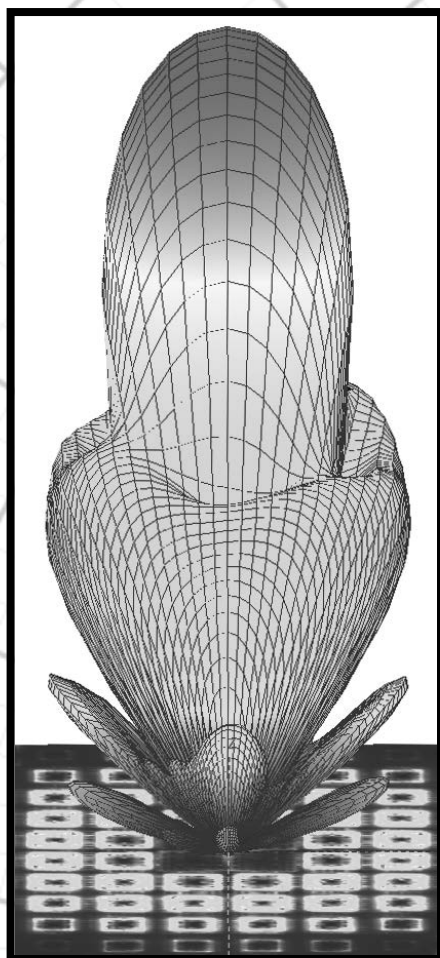
---

# Journal



February 2011

Vol. 26 No. 2



ISSN 1054-4887

**GENERAL PURPOSE AND SCOPE:** The Applied Computational Electromagnetics Society (*ACES*) Journal hereinafter known as the *ACES Journal* is devoted to the exchange of information in computational electromagnetics, to the advancement of the state-of-the art, and the promotion of related technical activities. The primary objective of the information exchange is to inform the scientific community on the developments of new computational electromagnetics tools and their use in electrical engineering, physics, or related areas. The technical activities promoted by this publication include code validation, performance analysis, and input/output standardization; code or technique optimization and error minimization; innovations in solution technique or in data input/output; identification of new applications for electromagnetics modeling codes and techniques; integration of computational electromagnetics techniques with new computer architectures; and correlation of computational parameters with physical mechanisms.

**SUBMISSIONS:** The *ACES Journal* welcomes original, previously unpublished papers, relating to applied computational electromagnetics. Typical papers will represent the computational electromagnetics aspects of research in electrical engineering, physics, or related disciplines. However, papers which represent research in applied computational electromagnetics itself are equally acceptable.

Manuscripts are to be submitted through the upload system of *ACES* web site <http://aces.ee.olemiss.edu> See "Information for Authors" on inside of back cover and at *ACES* web site. For additional information contact the Editor-in-Chief:

**Dr. Atef Elsherbeni**  
Department of Electrical Engineering  
The University of Mississippi  
University, MS 386377 USA  
Phone: 662-915-5382  
Email: [atef@olemiss.edu](mailto:atef@olemiss.edu)

**SUBSCRIPTIONS:** All members of the Applied Computational Electromagnetics Society are entitled to access and download the *ACES Journal* any published journal article available at <http://aces.ee.olemiss.edu>. Printed issues of the *ACES Journal* are delivered to institutional members. Each author of published papers receives a printed issue of the *ACES Journal* in which the paper is published.

**Back issues**, when available, are \$50 each. Subscription to *ACES* is through the web site. Orders for back issues of the *ACES Journal* and change of address requests should be sent directly to *ACES* office at:

Department of Electrical Engineering  
The University of Mississippi  
University, MS 386377 USA  
Phone: 662-915-7231  
Email: [aglisson@olemiss.edu](mailto:aglisson@olemiss.edu)

Allow four weeks advance notice for change of address. Claims for missing issues will not be honored because of insufficient notice, or address change, or loss in the mail unless the *ACES* office is notified within 60 days for USA and Canadian subscribers, or 90 days for subscribers in other countries, from the last day of the month of publication. For information regarding reprints of individual papers or other materials, see "Information for Authors".

**LIABILITY.** Neither *ACES*, nor the *ACES Journal* editors, are responsible for any consequence of misinformation or claims, express or implied, in any published material in an *ACES Journal* issue. This also applies to advertising, for which only camera-ready copies are accepted. Authors are responsible for information contained in their papers. If any material submitted for publication includes material which has already been published elsewhere, it is the author's responsibility to obtain written permission to reproduce such material.

**APPLIED  
COMPUTATIONAL  
ELECTROMAGNETICS  
SOCIETY  
JOURNAL**

February 2011  
Vol. 26 No. 2  
ISSN 1054-4887

**The ACES Journal is abstracted in INSPEC, in Engineering Index, DTIC, Science Citation Index Expanded, the Research Alert, and to Current Contents/Engineering, Computing & Technology.**

The illustrations on the front cover have been obtained from the research groups at the Department of Electrical Engineering, The University of Mississippi.

# THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

<http://aces.ee.olemiss.edu>

## EDITOR-IN-CHIEF

**Atef Elsherbeni**

University of Mississippi, EE Dept.  
University, MS 38677, USA

## ASSOCIATE EDITORS-IN-CHIEF

**Sami Barmada**

University of Pisa, EE Dept.  
Pisa, Italy, 56126

**Fan Yang**

University of Mississippi, EE Dept.  
University, MS 38677, USA

**Mohamed Bakr**

McMaster University, ECE Dept.  
Hamilton, ON, L8S 4K1, Canada

**Yasushi Kanai**

Niigata Inst. of Technology  
Kashiwazaki, Japan

**Mohammed Hadi**

Kuwait University, EE Dept.  
Safat, Kuwait

**Mohamed Abouzahra**

MIT Lincoln Laboratory  
Lexington, MA, USA

## EDITORIAL ASSISTANTS

**Matthew J. Inman**

University of Mississippi, EE Dept.  
University, MS 38677, USA

**Anne Graham**

University of Mississippi, EE Dept.  
University, MS 38677, USA

## EMERITUS EDITORS-IN-CHIEF

**Duncan C. Baker**

EE Dept. U. of Pretoria  
0002 Pretoria, South Africa

**Allen Glisson**

University of Mississippi, EE Dept.  
University, MS 38677, USA

**David E. Stein**

USAF Scientific Advisory Board  
Washington, DC 20330, USA

**Robert M. Bevensee**

Box 812  
Alamo, CA 94507-0516, USA

**Ahmed Kishk**

University of Mississippi, EE Dept.  
University, MS 38677, USA

## EMERITUS ASSOCIATE EDITORS-IN-CHIEF

**Alexander Yakovlev**

University of Mississippi, EE Dept.  
University, MS 38677, USA

**Erdem Topsakal**

Mississippi State University, EE Dept.  
Mississippi State, MS 39762, USA

## EMERITUS EDITORIAL ASSISTANTS

**Khaled ElMaghoub**

University of Mississippi, EE Dept.  
University, MS 38677, USA

**Mohamed Al Sharkawy**

Arab Academy for Science and  
Technology, ECE Dept.  
Alexandria, Egypt

**Christina Bonnington**

University of Mississippi, EE Dept.  
University, MS 38677, USA

## **FEBRUARY 2011 REVIEWERS**

**Iftikhar Ahmed  
Rodolfo Araneo  
Sami Barmada  
Deb Chatterjee  
Jingyi Chen  
William Coburn  
Jorge Costa  
Jianjun Ding  
Andrew L. Drozd  
Alistar Duffy  
Khaled ElMahgoub  
Nathan Ida  
Leo Kempel  
Marco Klingler**

**Giampiero Lovat  
Antonino Musolino  
Andrew Peterson  
Lorena Lozano Plata  
Levent Sevgi  
Fernando Teixeira  
Theodoros Tsiboukis  
Yasuhiro Tsunemitsu  
Ahmet Turk  
Veerakumar Venugopal  
Su Yan  
Korkut Yegin  
Amir Zaghloul**



# THE APPLIED COMPUTATIONAL ELECTROMAGNETICS SOCIETY

## JOURNAL

Vol. 26 No. 2

February 2011

### TABLE OF CONTENTS

“An Improved MM-PO Method with UV Technique for Scattering from an Electrically Large Ship on a Rough Sea Surface at Low Grazing Angle” S. Y. He, C. Li, F. Zhang, G. Q. Zhu, W. D. Hu, and W. X. Yu.....	87
“The PMC-Amended DB Boundary – A Canonical EBG Surface” P. Kildal, A. Kishk, M. Bosiljevac, and Z. Sipus.....	96
“Miniature Printed Magnetic Photonic Crystal Antennas Embedded into Vehicular Platforms” E. Irci, K. Sertel, and J. L. Volakis.....	109
“Performance Comparison between Rigorous and Asymptotic Techniques Applied to the Analysis of Wind Turbines” A. Tayebi, J. Gómez, I. González, L. Lozano, M. J. Algar, E. García, Í. Etayo, and F. Cátedra .....	115
“Dielectric Characterization and Optimization of Wide-band, Cavity-Backed Spiral Antennas” N. Rahman, A. Sharma, M. Afsar, S. Palreddy, and R. Cheung .....	123
“Modeling of CPW Based Passive Networks using Sonnet Simulations for High Efficiency Power Amplifier MMIC Design” V. Zomorrodian, U. K. Mishra, and R. A. York.....	131
“Design and SAR Reduction of the Vest Antenna using Metamaterial for Broadband Applications” M. Fallah, A. A. Heydari, A. R. Mallahzadeh, and F. H. Kashani.....	141
“Nonstandard Finite Difference Time Domain Algorithm for Berenger’s Perfectly Matched Layer” N. Okada and J. B. Cole .....	153
“Modified Adaptive Cross Approximation Algorithm for Analysis of Electromagnetic Problems” Z. N. Jiang, R. S. Chen, Z. H. Fan, Y. Y. An, M. M. Zhu, and K. W. Leung .....	160
“Gain and Bandwidth Limitations of Reflectarrays” B. Devireddy, A. Yu, F. Yang, and A. Z. Elsherbeni.....	170





## 2011 INSTITUTIONAL MEMBERS

DTIC-OCP LIBRARY  
8725 John J. Kingman Rd, Ste 0944  
Fort Belvoir, VA 22060-6218

AUSTRALIAN DEFENCE LIBRARY  
Northcott Drive  
Canberra, A.C.T. 2600 Australia

BEIJING BOOK CO, INC  
701 E Linden Avenue  
Linden, NJ 07036-2495

DARTMOUTH COLLEGE  
6025 Baker/Berry Library  
Hanover, NH 03755-3560

DSTO EDINBURGH  
AU/33851-AP, PO Box 830470  
Birmingham, AL 35283

SIMEON J. EARL – BAE SYSTEMS  
W432A, Warton Aerodome  
Preston, Lancs., UK PR4 1AX

ENGINEERING INFORMATION, INC  
PO Box 543  
Amsterdam, Netherlands 1000 Am

ETSE TELECOMUNICACION  
Biblioteca, Campus Lagoas  
Vigo, 36200 Spain

GA INSTITUTE OF TECHNOLOGY  
EBS-Lib Mail code 0900  
74 Cherry Street  
Atlanta, GA 30332

TIMOTHY HOLZHEIMER  
Raytheon  
PO Box 1044  
Rockwall, TX 75087

HRL LABS, RESEARCH LIBRARY  
3011 Malibu Canyon  
Malibu, CA 90265

IEE INSPEC  
Michael Faraday House  
6 Hills Way  
Stevenage, Herts UK SG1 2AY

INSTITUTE FOR SCIENTIFIC INFO.  
Publication Processing Dept.  
3501 Market St.  
Philadelphia, PA 19104-3302

LIBRARY – DRDC OTTAWA  
3701 Carling Avenue  
Ottawa, Ontario, Canada K1A OZ4

LIBRARY of CONGRESS  
Reg. Of Copyrights  
Attn: 407 Deposits  
Washington DC, 20559

LINDA HALL LIBRARY  
5109 Cherry Street  
Kansas City, MO 64110-2498

MISSOURI S&T  
400 W 14<sup>th</sup> Street  
Rolla, MO 56409

MIT LINCOLN LABORATORY  
Periodicals Library  
244 Wood Street  
Lexington, MA 02420

NATIONAL CHI NAN UNIVERSITY  
Lily Journal & Book Co, Ltd  
20920 Glenbrook Drive  
Walnut, CA 91789-3809

JOHN NORGARD  
UCCS  
20340 Pine Shadow Drive  
Colorado Springs, CO 80908

OSAMA MOHAMMED  
Florida International University  
10555 W Flagler Street  
Miami, FL 33174

NAVAL POSTGRADUATE SCHOOL  
Attn:J. Rozdal/411 Dyer Rd./ Rm 111  
Monterey, CA 93943-5101

NDL KAGAKU  
C/O KWE-ACCESS  
PO Box 300613 (JFK A/P)  
Jamaica, NY 11430-0613

OVIEDO LIBRARY  
PO BOX 830679  
Birmingham, AL 35283

DAVID PAULSEN  
E3Compliance  
1523 North Joe Wilson Road  
Cedr Hill, TX 75104-1437

PENN STATE UNIVERSITY  
126 Paterno Library  
University Park, PA 16802-1808

DAVID J. PINION  
1122 E Pike Street #1217  
SEATTLE, WA 98122

KATHERINE SIAKAVARA  
Gymnasiou 8  
Thessaloniki, Greece 55236

SWETS INFORMATION SERVICES  
160 Ninth Avenue, Suite A  
Runnemedede, NJ 08078

YUTAKA TANGE  
Maizuru Natl College of Technology  
234 Shiroya  
Maizuru, Kyoto, Japan 625-8511

TIB & UNIV. BIB. HANNOVER  
DE/5100/G1/0001  
Welfengarten 1B  
Hannover, Germany 30167

UEKAE  
PO Box 830470  
Birmingham, AL 35283

UNIV OF CENTRAL FLORIDA  
4000 Central Florida Boulevard  
Orlando, FL 32816-8005

UNIVERSITY OF COLORADO  
1720 Pleasant Street, 184 UCB  
Boulder, CO 80309-0184

UNIVERSITY OF KANSAS –  
WATSON  
1425 Jayhawk Blvd 210S  
Lawrence, KS 66045-7594

UNIVERSITY OF MISSISSIPPI  
JD Williams Library  
University, MS 38677-1848

UNIVERSITY LIBRARY/HKUST  
Clear Water Bay Road  
Kowloon, Honk Kong

CHUAN CHENG WANG  
8F, No. 31, Lane 546  
MingCheng 2nd Road, Zuoying Dist  
Kaoshiung City, Taiwan 813

THOMAS WEILAND  
TU Darmstadt  
Schlossgartenstrasse 8  
Darmstadt, Hessen, Germany 64289

STEVEN WEISS  
US Army Research Lab  
2800 Powder Mill Road  
Adelphi, MD 20783

YOSHIHIDE YAMADA  
NATIONAL DEFENSE ACADEMY  
1-10-20 Hashirimizu  
Yokosuka, Kanagawa,  
Japan 239-8686

## INFORMATION FOR AUTHORS

### PUBLICATION CRITERIA

Each paper is required to manifest some relation to applied computational electromagnetics. **Papers may address general issues in applied computational electromagnetics, or they may focus on specific applications, techniques, codes, or computational issues.** While the following list is not exhaustive, each paper will generally relate to at least one of these areas:

- 1. Code validation.** This is done using internal checks or experimental, analytical or other computational data. Measured data of potential utility to code validation efforts will also be considered for publication.
- 2. Code performance analysis.** This usually involves identification of numerical accuracy or other limitations, solution convergence, numerical and physical modeling error, and parameter tradeoffs. However, it is also permissible to address issues such as ease-of-use, set-up time, run time, special outputs, or other special features.
- 3. Computational studies of basic physics.** This involves using a code, algorithm, or computational technique to simulate reality in such a way that better, or new physical insight or understanding, is achieved.
- 4. New computational techniques** or new applications for existing computational techniques or codes.
- 5. “Tricks of the trade”** in selecting and applying codes and techniques.
- 6. New codes, algorithms, code enhancement, and code fixes.** This category is self-explanatory, but includes significant changes to existing codes, such as applicability extensions, algorithm optimization, problem correction, limitation removal, or other performance improvement. **Note: Code (or algorithm) capability descriptions are not acceptable, unless they contain sufficient technical material to justify consideration.**
- 7. Code input/output issues.** This normally involves innovations in input (such as input geometry standardization, automatic mesh generation, or computer-aided design) or in output (whether it be tabular, graphical, statistical, Fourier-transformed, or otherwise signal-processed). Material dealing with input/output database management, output interpretation, or other input/output issues will also be considered for publication.
- 8. Computer hardware issues.** This is the category for analysis of hardware capabilities and limitations of various types of electromagnetics computational requirements. Vector and parallel computational techniques and implementation are of particular interest. Applications of interest include, but are not limited to,

antennas (and their electromagnetic environments), networks, static fields, radar cross section, inverse scattering, shielding, radiation hazards, biological effects, biomedical applications, electromagnetic pulse (EMP), electromagnetic interference (EMI), electromagnetic compatibility (EMC), power transmission, charge transport, dielectric, magnetic and nonlinear materials, microwave components, MEMS, RFID, and MMIC technologies, remote sensing and geometrical and physical optics, radar and communications systems, sensors, fiber optics, plasmas, particle accelerators, generators and motors, electromagnetic wave propagation, non-destructive evaluation, eddy currents, and inverse scattering.

Techniques of interest include but not limited to frequency-domain and time-domain techniques, integral equation and differential equation techniques, diffraction theories, physical and geometrical optics, method of moments, finite differences and finite element techniques, transmission line method, modal expansions, perturbation methods, and hybrid methods.

Where possible and appropriate, authors are required to provide statements of quantitative accuracy for measured and/or computed data. This issue is discussed in “Accuracy & Publication: Requiring, quantitative accuracy statements to accompany data,” by E. K. Miller, *ACES Newsletter*, Vol. 9, No. 3, pp. 23-29, 1994, ISBN 1056-9170.

### SUBMITTAL PROCEDURE

All submissions should be uploaded to ACES server through ACES web site (<http://aces.ee.olemiss.edu>) by using the upload button, journal section. Only pdf files are accepted for submission. The file size should not be larger than 5MB, otherwise permission from the Editor-in-Chief should be obtained first. Automated acknowledgment of the electronic submission, after the upload process is successfully completed, will be sent to the corresponding author only. It is the responsibility of the corresponding author to keep the remaining authors, if applicable, informed. Email submission is not accepted and will not be processed.

### EDITORIAL REVIEW

**In order to ensure an appropriate level of quality control,** papers are peer reviewed. They are reviewed both for technical correctness and for adherence to the listed guidelines regarding information content and format.

### PAPER FORMAT

Only camera-ready electronic files are accepted for publication. The term **“camera-ready”** means that the material is neat, legible, reproducible, and in accordance with the final version format listed below.

The following requirements are in effect for the final version of an ACES Journal paper:

1. The paper title should not be placed on a separate page.

The title, author(s), abstract, and (space permitting) beginning of the paper itself should all be on the first page. The title, author(s), and author affiliations should be centered (center-justified) on the first page. The title should be of font size 16 and bolded, the author names should be of font size 12 and bolded, and the author affiliation should be of font size 12 (regular font, neither italic nor bolded).

2. An abstract is required. The abstract should be a brief summary of the work described in the paper. It should state the computer codes, computational techniques, and applications discussed in the paper (as applicable) and should otherwise be usable by technical abstracting and indexing services. The word "Abstract" has to be placed at the left margin of the paper, and should be bolded and italic. It also should be followed by a hyphen (–) with the main text of the abstract starting on the same line.
3. All section titles have to be centered and all the title letters should be written in caps. The section titles need to be numbered using roman numbering (I. II. ....)
4. Either British English or American English spellings may be used, provided that each word is spelled consistently throughout the paper.
5. Internal consistency of references format should be maintained. As a guideline for authors, we recommend that references be given using numerical numbering in the body of the paper (with numerical listing of all references at the end of the paper). The first letter of the authors' first name should be listed followed by a period, which in turn, followed by the authors' complete last name. Use a coma (,) to separate between the authors' names. Titles of papers or articles should be in quotation marks (" "), followed by the title of journal, which should be in italic font. The journal volume (vol.), issue number (no.), page numbering (pp.), month and year of publication should come after the journal title in the sequence listed here.
6. Internal consistency shall also be maintained for other elements of style, such as equation numbering. Equation numbers should be placed in parentheses at the right column margin. All symbols in any equation have to be defined before the equation appears or right immediately following the equation.
7. The use of SI units is strongly encouraged. English units may be used as secondary units (in parentheses).
8. Figures and tables should be formatted appropriately (centered within the column, side-by-side, etc.) on the page such that the presented data appears close to and after it is being referenced in the text. When including figures and tables, all care should be taken so that they will appear appropriately when printed in black and white. For better visibility of paper on computer screen, it is good to make color figures with different line styles for figures with multiple curves. Colors should also be tested to insure their ability to be distinguished after

black and white printing. Avoid the use of large symbols with curves in a figure. It is always better to use different line styles such as solid, dotted, dashed, etc.

9. A figure caption should be located directly beneath the corresponding figure, and should be fully justified.
10. The intent and meaning of all text must be clear. For authors who are not masters of the English language, the ACES Editorial Staff will provide assistance with grammar (subject to clarity of intent and meaning). However, this may delay the scheduled publication date.
11. Unused space should be minimized. Sections and subsections should not normally begin on a new page.

ACES reserves the right to edit any uploaded material, however, this is not generally done. It is the author(s) responsibility to provide acceptable camera-ready files in pdf and MSWord formats. Incompatible or incomplete files will not be processed for publication, and authors will be requested to re-upload a revised acceptable version.

#### **COPYRIGHTS AND RELEASES**

Each primary author must execute the online copyright form and obtain a release from his/her organization vesting the copyright with ACES. Both the author(s) and affiliated organization(s) are allowed to use the copyrighted material freely for their own private purposes.

Permission is granted to quote short passages and reproduce figures and tables from and ACES Journal issue provided the source is cited. Copies of ACES Journal articles may be made in accordance with usage permitted by Sections 107 or 108 of the U.S. Copyright Law. This consent does not extend to other kinds of copying, such as for general distribution, for advertising or promotional purposes, for creating new collective works, or for resale. The reproduction of multiple copies and the use of articles or extracts for commercial purposes require the consent of the author and specific permission from ACES. Institutional members are allowed to copy any ACES Journal issue for their internal distribution only.

#### **PUBLICATION CHARGES**

All authors are allowed for 8 printed pages per paper without charge. Mandatory page charges of \$75 a page apply to all pages in excess of 8 printed pages. Authors are entitled to one, free of charge, copy of the printed journal issue in which their paper was published. Additional reprints are available for \$ 50. Requests for additional re-prints should be submitted to the managing editor or ACES Secretary.

Corresponding author is required to complete the online form for the over page charge payment right after the initial acceptance of the paper is conveyed to the corresponding author by email.

**ACES Journal is abstracted in INSPEC, in Engineering Index, DTIC, Science Citation Index Expanded, the Research Alert, and to Current Contents/Engineering, Computing & Technology.**