

# **Boundary Elements and Other Mesh Reduction Methods XXVIII**

**WIT***PRESS*

WIT Press publishes leading books in Science and Technology.

Visit our website for the current list of titles.

[www.witpress.com](http://www.witpress.com)

**WIT***eLibrary*

Home of the Transactions of the Wessex Institute.

Papers presented at BEM/MRM XXVIII are archived in the WIT eLibrary in volume 42 of WIT Transactions on Modelling and Simulation (ISSN 1743-355X).

The WIT electronic-library provides the international scientific community with immediate and permanent access to individual papers presented at WIT conferences.

<http://library.witpress.com>

# Transactions Editor

**Carlos Brebbia**  
**Wessex Institute of Technology**  
**Ashurst Lodge, Ashurst**  
**Southampton SO40 7AA, UK**  
**Email: carlos@wessex.ac.uk**

---

## WIT Transactions on Modelling and Simulation

### Editorial Board

**C Alessandri**  
Universita di Ferrara  
Italy

**J Baish**  
Bucknell University  
USA

**D E Beskos**  
University of Patras  
Greece

**J A Bryant**  
University of Exeter  
UK

**M A Celia**  
Princeton University  
USA

**J J Connor**  
Massachusetts Institute  
of Technology  
USA

**M A Atherton**  
South Bank University  
UK

**C D Bertram**  
The University of New  
South Wales  
Australia

**M Bonnet**  
Ecole Polytechnique  
France

**M B Bush**  
The University of Western  
Australia  
Australia

**A H-D Cheng**  
University of Mississippi  
USA

**D E Cormack**  
University of Toronto  
Canada

**D F Cutler**  
Royal Botanic Gardens  
UK

**G De Mey**  
Ghent State University  
Belgium

**Q H Du**  
Tsinghua University  
China

**A El-Zafrany**  
Cranfield University  
UK

**S Finger**  
Carnegie Mellon University  
USA

**M J Fritzier**  
University of Calgary  
Canada

**G S Gipson**  
Oklahoma State University  
USA

**K Hayami**  
National Institute of Informatics  
Japan

**D B Ingham**  
The University of Leeds  
UK

**D L Karabalis**  
University of Patras  
Greece

**E R de Arantes e Oliveira**  
Insituto Superior Tecnico  
Portugal

**J Dominguez**  
University of Seville  
Spain

**S Elghobashi**  
University of California  
Irvine  
USA

**P Fedelinski**  
Silesian Technical  
University  
Poland

**J I Frankel**  
University of Tennessee  
USA

**L Gaul**  
Universitat Stuttgart  
Germany

**S Grilli**  
University of Rhode Island  
USA

**J A C Humphrey**  
Bucknell University  
USA

**N Kamiya**  
Nagoya University  
Japan

**J T Katsikadelis**  
National Technical  
University of Athens  
Greece

**H Lui**

State Seismological Bureau Harbin  
China

**R A Meric**

Research Institute for Basic Sciences  
Turkey

**K Onishi**

Ibaraki University  
Japan

**M Predeleanu**

University Paris VI  
France

**S Rinaldi**

Politecnico di Milano  
Italy

**G Schmid**

Ruhr-Universität Bochum  
Germany

**X Shixiong**

Fudan University  
China

**V Sladek**

Slovak Academy of Sciences  
Slovakia

**J Stasiek**

Technical University of Gdansk  
Poland

**M Tanaka**

Shinshu University  
Japan

**T Tran-Cong**

University of Southern Queensland  
Australia

**W J Mansur**

COPPE/UFRJ  
Brazil

**J Mikielewicz**

Polish Academy of Sciences  
Poland

**E L Ortiz**

Imperial College London  
UK

**D Qinghua**

Tsinghua University  
China

**T J Rudolphi**

Iowa State University  
USA

**A P S Selvadurai**

McGill University  
Canada

**P Skerget**

University of Maribor  
Slovenia

**T Speck**

Albert-Ludwigs-Universität  
Freiburg  
Germany

**S Syngellakis**

University of Southampton  
UK

**N Tosaka**

Nihon University  
Japan

**W S Venturini**

University of Sao Paulo  
Brazil

**J F V Vincent**  
The University of Bath  
UK

**Z-Y Yan**  
Peking University  
China

**G Zharkova**  
Institute of Theoretical and Applied  
Mechanics  
Russia

**J R Whiteman**  
Brunel University  
UK

**K Yoshizato**  
Hiroshima University  
Japan

TWENTY-EIGHTH WORLD CONFERENCE ON  
BOUNDARY ELEMENTS AND  
OTHER MESH REDUCTION METHODS

**BEM/MRM XXVIII**

**CONFERENCE CHAIRMEN**

**C. A. Brebbia**

*Wessex Institute of Technology, UK*

**J. T. Katsikadelis**

*National Technical University of Athens, Greece*

**INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE**

C Alessandri	M Hribersek	J J Rencis
D E Beskos	M S Ingber	V Roje
M Bonnet	D B Ingham	T J Rudolphi
P Broz	M A Jaswon	G Rus Carlborg
M Bush	M Kanoh	B Sarler
C-S Chen	A J Kassab	E Schnack
A H-D Cheng	E Kita	A P S Selvadurai
T G Davies	G Kuhn	X Shu
A J Davies	V Leitao	L Skerget
G De Mey	G D Manolis	V Sladek
V G DeGiorgi	W J Mansur	S Syngellakis
J Dominguez	J C Miranda Valenzuela	A Tadeu
A El-Zafrany	K H Muci-Kuchler	M Tanaka
G Fasshauer	Y Ochiai	N Tosaka
J Frankel	K Onishi	T Tran-Cong
L Gaul	D Poljak	W S Venturini
G S Gipson	V Popov	O von Estorff
K Hayami	H Power	T Wu
Y C Hon	M Predeleanu	S-P Zhu

**Organised by**

Wessex Institute of Technology, UK.

**Sponsored by**

International Journal of Engineering Analysis with Boundary Elements  
(EABE)

**Boundary Elements  
and  
Other Mesh Reduction Methods  
XXVIII**

**Editors**

**C. A. Brebbia**

*Wessex Institute of Technology, UK*

**J. T. Katsikadelis**

*National Technical University of Athens, Greece*

**WIT**PRESS Southampton, Boston



**C. A. Brebbia**

*Wessex Institute of Technology, UK*

**J. T. Katsikadelis**

*National Technical University of Athens, Greece*

**WIT Press**

Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK

Tel: 44 (0) 238 029 3223; Fax: 44 (0) 238 029 2853

E-Mail: [witpress@witpress.com](mailto:witpress@witpress.com)

<http://www.witpress.com>

For USA, Canada and Mexico

**Computational Mechanics Inc**

25 Bridge Street, Billerica, MA 01821, USA

Tel: 978 667 5841; Fax: 978 667 7582

E-Mail: [infousa@witpress.com](mailto:infousa@witpress.com)

<http://www.witpress.com>

British Library Cataloguing-in-Publication Data

A Catalogue record for this book is available  
from the British Library

ISBN: 1-84564-164-7

ISSN: 1746-4064 (print)

ISSN: 1743-355X (on-line)

*The texts of the papers in this volume were set  
individually by the authors or under their supervision.  
Only minor corrections to the text may have been carried  
out by the publisher.*

No responsibility is assumed by the Publisher, the Editors and Authors for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions or ideas contained in the material herein.

© WIT Press 2006.

Printed in Great Britain by Athenaeum Press Ltd., Gateshead.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the Publisher.

## Preface

The present volume contains the edited proceedings of the 28<sup>th</sup> World Conference on Boundary Elements and other Mesh Reduction Methods (BEM/MRM28) held at the beautiful island of Skiathos, Greece, in May 2006. This is the second conference of this series organized in Greece. The first (BEM23) took place in the island Lemnos in May 2001.

This series of international conferences, organized annually since 1978, with the collaboration of distinguished engineers and scientists at various places of the world, has served as the established forum for the advancement of the Boundary Element Method. It has attracted innovative contributions in the areas of fundamental principles, theoretical, computational and algorithmic aspects of the method as well as advanced applications to small and large scale engineering problems of the real world. All leading researchers in the five continents of the world, involved in the development of the BEM, have attended more than a few of these meetings and have presented original papers, which have helped to develop the BEM into a powerful modern computational tool for solving problems of engineering praxis. It is not an exaggeration to say that the proceedings of these BEM conferences together with the International Journal of Engineering Analysis with Boundary Elements constitute the BEM Treasure Chest of the BEM community.

The development of mesh reduction methods to simplify the computational techniques has attracted the attention of the community. As the BEM is inherently a mesh reduction method, the world conference has widened its scope to encompass these methods, hence the new name BEM/MRM. This extension has added vitality to these international scientific meetings by attracting new promising researchers in the field.

The present volume captures the results of excellent BEM/MRM work carried out by researchers from various parts of the world. It covers advanced formulations, advanced structural applications, damage and fracture mechanics, dynamics and vibrations, fluid flow, heat and mass transfer, electrical and electromagnetic problems and computational techniques.

The editors would like to express their gratitude to the members of the

International Scientific Advisory Committee and to other colleagues, for their assiduous review of abstracts and follow-up papers included in this book. Their diligent work has ensured the high quality of this volume. Finally, the authors are to be commended for the excellent contributions, which advance the area of computational methods and ensure the longevity of the BEM after nearly 30 years and present the MRM as the computational tool of the 21<sup>st</sup> century

The editors  
Skiathos, 2006

# Contents

## Section 1: Advanced formulations

Explicit formulations for advanced Green's functions with built-in boundaries <i>G. S. Gipson &amp; B. W. Yeigh</i> .....	3
The meshless analog equation method: a new highly accurate truly mesh-free method for solving partial differential equations <i>J. T. Katsikadelis</i> .....	13
Solving Poisson's equations by the Discrete Least Square Meshless method <i>H. Arzani &amp; M. H. Afshar</i> .....	23
Evaluation of Asian option by using RBF approximation <i>E. Kita, Y. Goto, F. Zhai &amp; K. Shen</i> .....	33
Bumps modeling using the principal shear stresses <i>P. P. Prochazka &amp; A. Yiakoumi</i> .....	41
Integral equations for elastic problems posed in principal directions: application for adjacent domains <i>A. N. Galybin &amp; Sh. A. Mukhamediev</i> .....	51
Matrix decomposition MFS algorithms <i>A. Karageorghis &amp; Y.-S. Smyrlis</i> .....	61
A meshfree minimum length method <i>G. R. Liu, K. Y. Dai &amp; X. Han</i> .....	69
DRM formulation for axisymmetric laser-material interactions <i>R. Gospavić, V. Popov, M. Srecković &amp; G. Todorović</i> .....	79

## **Section 2: Advanced structural applications**

Large deflection analysis of membranes containing rigid inclusions <i>M. S. Nerantzaki &amp; C. B. Kandilas</i> .....	91
Shear deformation effect in nonlinear analysis of spatial beams subjected to variable axial loading by BEM <i>E. J. Sapountzakis &amp; V. G. Mokos</i> .....	101
High rate continuum modeling mesh reduction methodologies and advanced applications <i>E. L. Baker, D. Pfau, J. M. Pincay, T. Vuong &amp; K. W. Ng</i> .....	111
Boundary element analysis of strain fields in InAs/GaAs quantum wire structures <i>F. Han, E. Pan &amp; J. D. Albrecht</i> .....	119

## **Section 3: Heat and mass transfer**

A meshless solution procedure for coupled turbulent flow and solidification in steel billet casting <i>B. Šarler, R. Vertnik &amp; G. Manojlović</i> .....	131
Conduction heat transfer with nonzero initial conditions using the Boundary Element Method in the frequency domain <i>N. Simões, A. Tadeu &amp; W. Mansur</i> .....	143
The heat release rate of the fire predicted by sequential inverse method <i>W. S. Lee &amp; S. K. Lee</i> .....	153

## **Section 4: Electrical engineering and electromagnetics**

Computation of maximal electric field value generated by a power substation <i>N. Kovač, D. Poljak, S. Kraljević &amp; B. Jajac</i> .....	165
Transient analysis of coated thin wire antennas in free space via the Galerkin-Bubnov indirect Boundary Element Method <i>D. Poljak &amp; C. A. Brebbia</i> .....	175
Synthesis method of the Cassegrain type unsymmetrical antennas <i>R. Dufrière, W. Kołosowski, E. Sędek &amp; A. Jeziorski</i> .....	187
Numerical simulation of a 3D virtual cathode oscillator <i>F. Assous</i> .....	193

## **Section 5: Fluid flow**

Iterative coupling in fluid-structure interaction: a BEM-FEM based approach <i>D. Soares Jr, W. J. Mansur &amp; O. von Estorff</i> .....	205
The Complex Variable Boundary Element Method for potential flow problems <i>M. Mokry</i> .....	211
BE DRM-MD for two-phase flow through porous media <i>T. Samardzioska &amp; V. Popov</i> .....	221
Boundary element method for the analysis of flow and concentration in a water reservoir <i>M. Kanoh, N. Nakamura, T. Kuroki &amp; K. Sakamoto</i> .....	231

## **Section 6: Computational techniques**

A Laplace transform boundary element solution for the biharmonic diffusion equation <i>A. J. Davies &amp; D. Crann</i> .....	243
Transformative models in reliability assessment of structures <i>P. Brož</i> .....	253
Rapid re-analysis in BEM elastostatic calculations <i>J. Trevelyan &amp; D. J. Scales</i> .....	263

## **Section 7: Dynamics and vibrations**

3D wave field scattered by thin elastic bodies buried in an elastic medium using the Traction Boundary Element Method <i>P. Amado Mendes &amp; A. Tadeu</i> .....	275
Wave propagation in elastic and poroelastic media in the frequency domain by the boundary element method <i>M. A. C. Ferro &amp; W. J. Mansur</i> .....	285
A space-time boundary element method for 3D elastodynamic analysis <i>J. X. Zhou &amp; T. G. Davies</i> .....	295

**Section 8: Damage fracture and mechanics**

Wave motion through cracked, functionally graded materials by BEM  
*G. D. Manolis, T. V. Rangelov & P. S. Dineva*..... 307

Boundary element formulation applied to multi-fractured bodies  
*E. D. Leonel, O. B. R. Lovón & W. S. Venturini* ..... 317

Penalty formulation of damage in classical composites  
*P. Procházka & J. Matyáš* ..... 329

**Author Index** ..... 339