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of Offshore Structures

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with Free Boundaries

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G. F. Pinder
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An Introduction

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Boca Raton, Florida, USA

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Working Conference
Aalborg, Denmark, May 6-8, 1987

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J. A. Trangenstein
Multiphase Flow in Porous Media
Mechanics, Mathematics, and Numerics
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Approach in BEM
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Architecture, Algorithms, and Applications

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for Engineering Design
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The Mathematics of Blunt Body Sampling
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Vol. 39: S.L Coh, C G Speziale (Eds )
Recent Advances in Engineering Science
A Symposium dedicated to A Cemal Engin
June 20-22, 1988, Berkeley, California
XVIII, 268 pages. 1989
PREFACE

The 25th Anniversary Meeting of the Society of Engineering Science was held as a joint conference with the Applied Mechanics Division of the American Society of Mechanical Engineers at the University of California, Berkeley from June 20–22, 1988. With the encouragement and support of the SES, we decided to organize a symposium in honor of A. C. Eringen: the founding president of the Society of Engineering Science who provided pioneering leadership during the critical first decade of the Society’s existence. We felt that there was no better way to do this than with a Symposium on Engineering Science — the field that A. C. Eringen has devoted his life to. Professor Eringen had the foresight, even in his own early work, to see the need for an intimate amalgamation of engineering and science (transcending the bounds of the traditional engineering disciplines) to address unsolved problems of technological importance. Sustained by the belief that there was the need to provide a forum for researchers who had embraced this broader interdisciplinary approach, Professor Eringen founded the Society of Engineering Science and the International Journal of Engineering Science in 1963. Since that time, he has made countless contributions to the advancement of engineering science through his research, educational and organizational activities.

The participants in the Symposium were former students and colleagues of Professor Eringen who have been strongly influenced by his professional activities and research in engineering science. Of the 40 participants: 26 were from the United States, 3 from France, 3 from Japan, 4 from Romania, 2 from the Soviet Union, 1 from Sweden, and 1 from Turkey (thus giving the Symposium a strong international flavor). At the Symposium, 22 papers were scheduled to be presented along with an open forum on future directions of research in engineering science that generated a lively and interesting discussion. An additional 5 papers were accepted for publication in this volume from authors abroad who were invited but were not able to attend the Symposium due to travel problems. The full text of 25 of the papers are presented in this volume along with the abstracts of the remaining 2 papers which will be published at a later date elsewhere. The papers in this volume cover a wide range of topics in engineering science including computational fluid dynamics, turbulence, mixture theory, compressible flow, linear and nonlinear elasticity, plasticity, micropolar media, electromagnetic solids and fluids, relativity theory, and random vibrations. Many of the papers contain results of recent research in fields that A. C. Eringen played an instrumental role in developing during the past four decades. It is our hope that this volume will provide the reader with an interesting view of contemporary research in engineering science.
We would like to thank the Organizing Committee of the Silver Anniversary Celebration of the Society of Engineering Science (in particular, Professor R. P. McNitt) for their financial support and encouragement in organizing the Eringen Symposium. Likewise, we would like to thank the authors and apologize to any colleagues and friends of Professor Eringen who may have been inadvertently overlooked when the Symposium was organized. Our special thanks go to Professor George Johnson, Professor Michael Carroll and Nanette Pike of the University of California at Berkeley for their assistance with the local arrangements for the Symposium and to Springer-Verlag for their interest in this program. Finally, we would like to express our deep appreciation to Professor A. C. Eringen without whose efforts in founding and nurturing the Society of Engineering Science there would not have been a 25th anniversary to celebrate this year.

Severino L. Koh
Charles G. Speziale
A. CEMAL ERINGEN

Founding President of the Society of Engineering Science
DEDICATION

When he began his professional life as a research engineer in the Turkish Air League in 1943, or even as late as 1948 when he accepted a position on the faculty of the Illinois Institute of Technology, A. Cemal Eringen could not have thought of someday being counted among a new breed of engineering scientists. In those early days, engineering and science clearly defined distinct academic fields of study, and the practitioners - the engineers and the scientists - belonged to decidedly different groups of professionals. There were then no programs in engineering science and the term had not yet been coined. It was when Eringen joined the faculty of Purdue University in 1953 that the concept of engineering science began to blossom. Eringen himself became one of the most distinguished proponents of a new academic program offered by a newly created Division of Engineering Sciences. This was to be among the first in the United States. During those formative years (and to some extent, even to this day), the engineering science spirit had been elusive. Engineering science meant different things to different people; the name itself appeared to some to be self-contradictory and convoluted. At the outset, it suffered from a lack of recognition and identity as a discipline (or "non-discipline") of study or as a concept in engineering education and practice. Yet the philosophy underlying this emerging field of intellectual activity was never blurred in the mind of Eringen. It is this clarity of thought coupled with an unswerving belief in the need for redirection away from narrow specializations that motivated Eringen to found a new periodical and a new professional society.

In his writings and in his speeches, Eringen articulated a strong conviction for the pertinent role that engineering science must play in the development of the total person in this technologically oriented society. On the founding of the International Journal of Engineering Science in 1963, he noted that "the specialized scientist or engineer, handicapped by a peculiar lack of training in fundamentals, is not equipped to explore the most interesting interdisciplinary regions, [in which] areas of cross-fertilization one finds the root system of science." In a vivid Emersonian tone, he quoted from The American Scholar: "...unfortunately, this original unit, this fountain of power, has been so distributed to multitudes, has been so minutely subdivided and peddled out, that it is spilled into drops, and cannot be gathered. The state of the society is one in which members have suffered amputation from the trunk, and strut about so many walking monsters - a good finger, a neck, a stomach, an elbow, but never a man."

The new journal immediately provided a forum dedicated to the "re-establishment of a common tongue between engineer and scientist." It encouraged the publication of serious research works of depth and breadth at the frontier areas of science and engineering, particularly on topics transcending the traditional boundaries of established disciplines. The journal became the pace-setter for workers in the
various fields of engineering science. A few months after the launching of the International Journal of Engineering Science, on November 4, 1963 (at Purdue University, West Lafayette, Indiana), Eringen stood before an audience of some 400 participants consisting of physicists, chemists, mathematicians, and engineers of different backgrounds and specializations to preside over the inauguration of the Society of Engineering Science. As Founding President of the new society, he worked with extreme diligence and dedication to bring this group of engineers and scientists together in a society "dedicated to the advancement of interdisciplinary research and the establishment of a bridge between science and engineering."

Eringen contributed immeasurably to the cause of engineering science through the initiation and early development of the society. More than this, Eringen has set himself up as a personification of a true engineering scientist. This is evident in the extensive and outstanding research that he has accomplished through the years covering wide-ranging topics in the classical fields of theoretical and applied mechanics, in continuum physics, applied mathematics and biomechanics. While at Illinois Institute of Technology (1948-1953), he was largely occupied with research in classical elasticity, in boundary value problems dealing with beams, plates, shells, and sandwich structures. This interest continued for a while during the early years that he spent at Purdue University (1953-1966). During this time, he also did research on waves, dynamic loads and impact on beams, plates, and elastic bodies with spherical cavities. He initiated studies on random vibrations and stochastic loads; his was the first paper on this subject to be published in the ASME Journal of Applied Mechanics. The techniques that he developed in this area are now extensively used in the analysis of the behavior of structures under wind loads and earthquakes. During the early 1960's, Eringen worked extensively in continuum physics, developing nonlinear theories in elasticity, fluid dynamics, visco-elasticity, electromagnetic interactions in solids and fluids (in both classical and relativistic frameworks), and chemically-reacting media. It was during this time that he participated in the renewed interest in the mechanics of Cosserat continua and initiated his "micromorphic theory" of continua. His seminal work in this field has been vigorously followed by researchers all over the world.

Eringen's interest in the micromorphic theory continued when he joined the faculty of Princeton University in 1966. During the early Princeton years, he concentrated on the application of this theory to turbulence, liquid crystals, polymers, suspensions, biomechanics, and composite materials. He has always kept a deep interest in questions related to the foundations of continuum mechanics and thermodynamics. In recent years, Eringen has been the most articulate and active proponent of the nonlocal theory of continua with applications to dislocation theory, fracture problems, surface physics, composite materials, and turbulence.

Eringen has a most impressive list of publications including, to date, 187 papers, 120 technical reports, seven books (with two more
under preparation), not counting 10 books that he has edited or contributed to. An earlier, less complete listing of Eringen's publications is given by Maugin (1982).

Eringen's renown as an educator, lecturer and prolific author has attracted to him graduate students and visiting scholars from around the world. To date, 35 Ph.D. students and 15 M.S. students have completed their studies under his guidance. Twenty-three professors and visiting scholars have also joined him for short and long-term collaborations on research projects of mutual interest. He is sought after throughout the world as a lecturer and has had many presentations at national and international congresses, symposia and summer schools. Recognition of Eringen's accomplishments has been widespread. In 1957, Eringen was awarded a Certificate of Achievement by the Polytechnic Institute of Brooklyn. He was named the Outstanding Researcher of the Year (1962-63) by the Society of Sigma Xi. The Society of Engineering Science presented Eringen with the Distinguished Service Award in 1973, two Certificates of Appreciation in 1974, and established its first medal in 1976 in his honor (the A. C. Eringen Medal) naming him the first recipient. Eringen was elected Honorary Fellow of the Royal Society of Edinburgh in 1980 and conferred the Doctor of Laws degree (honoris causa) by the University of Glasgow in 1981. He was named Best Engineering Scientist by Michigan Technological University in 1983.

In truth, A. Cemal Eringen has made outstanding contributions as a teacher and researcher, and his impact on engineering science cannot be denied. In his sustained, prolific contributions to a wide variety of fields, he has been the personification of a true engineering scientist. For his vision of engineering science, for his dedication to the establishment of what is now a significant professional society, and for his uncompromising pursuit of excellence, this symposium is dedicated to A. Cemal Eringen. The participants in this symposium are former students and colleagues of Professor Eringen who have been strongly influenced by his professional activities and research in engineering science. It is with affection and gratitude for the impact that he has had on our lives and it is with respect for his accomplishments as a teacher and scholar, that we have organized this symposium in commemoration of the 25th Anniversary of the Society of Engineering Science.

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THE ERINGEN SYMPOSIUM: RECENT ADVANCES IN ENGINEERING SCIENCE

June 20 - 22, 1988
University of California at Berkeley
Berkeley, CA USA

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Monday, June 20

SESSION 1  (10:00 a.m. - 12:00 noon)

Advances in Adaptive Methods in Computational Fluid Dynamics
J. T. Oden, University of Texas at Austin

On Helicity Fluctuations and the Energy Cascade in Turbulence
C. G. Speziale, ICASE - NASA Langley Research Center

A Continuum Model of Liquid-Gas Mixture
Al Ayham Al Assaad and J. S. Darrozes, ENSTA, France

The Propagation of a Normal Shock in a Non-Uniform Duct
A. Suresh, Sverdrup Technology, Ohio

Flow of a Mixture of Two Micromorphic Materials
A. D. Kirwan, Jr., Old Dominion University and P. Reinersman,
University of South Florida

SESSION 2  (1:00 p.m. - 3:05 p.m.)

Shear Band Formation in an Isotropic Micropolar Elastic Solid
M. N. L. Narasimhan and M. Kumazawa, Oregon State University

Computer Tests of Rubber Elasticity
J. H. Weiner and J. Gao, Brown University

Finite Element Analysis of Large Strain Elastic-Plastic Solids
J. D. Lee, National Bureau of Standards, Maryland

On the Mechanics of Flaws Near and at an Interface in Bonded
Nonhomogeneous Materials
F. Erdogan and P. F. Joseph, Lehigh University

Consideration of the Plasticity Theory of Granular Materials
M. Satake, Tohoku University, Japan
SESSION 3  (3:30 p.m. - 6:00 p.m.)

Nonlinear Surface-Wave and Resonator Effects in Magnetostrictive Crystals
G. A. Maugin, University of Paris (VI), France

Electromagnetic Tornadoes in Earth’s Ionosphere and Magnetosphere
T. S. Chang, G. B. Crew and J. M. Retterer, Center for Space Research, MIT

Effect of Nonuniformity on Earthquake Response of a Shear Beam Structure
Lin Su and G. Ahmadi, Clarkson University

Stability of Flexible Structures with Random Parameters
F. Kozin, Polytechnic University

Material Multipole Modellings of Electromagnetic Coupled Defects in Elastic Solids
R. K. T. Hsieh, Royal Institute of Technology, Sweden

Tuesday, June 21  (8:30 a.m. - 10:30 a.m.)

SESSION 4

Dislocation Dynamics in Anisotropic Piezoelectric Crystals: Influence of the Disturbance in the Electric Field
S. Minagawa, University of Electro-Communications, Japan

Certain Basis Functions for Biharmonic and Laplace’s Equations and Applications
A. K. Naghdi, Purdue University School of Engineering and Technology at Indianapolis

A New Set of Non-Classical Orthogonal Polynomials in the Solution of Anharmonic Oscillator Problems
Nasit Ari, Lafayette College

Particulate Science and Technology Today
T. Ariman, University of Tulsa

On the Boundary Value Problems in Nonlocal Elasticity
S. B. Altan, Princeton University
SESSION 5  (1:00 p.m. - 3:05 p.m.)

Dynamics of Viscoelastic Media with Internal Oscillators
V. N. Nikolaevskii, USSR Academy of Sciences

Three-Dimensional and Four-Dimensional Aspects of Human Penetration
and Summary of Nature
K. Kondo, C.P.N.P., Japan

OPEN FORUM ON FUTURE DIRECTIONS OF RESEARCH IN ENGINEERING SCIENCE
CONTENTS

ADVANCES IN ADAPTIVE METHODS IN COMPUTATIONAL FLUID MECHANICS
J. Tinsley Oden.......................... 1

ELECTROMAGNETIC TORNADOES IN EARTH'S IONOSPHERE AND MAGNETOSPHERE
T. Chang, G. B. Crew, and J. M. Retterer..................... 12

TOWARD A CONTINUUM THEORY OF LIQUID–GAS MIXTURES
A. A. Al Assa'ad and J. S. Darrozes.......................... 21

A MIXTURE OF TWO MICROMORPHIC MATERIALS
A. D. Kirwan, Jr. and P. Reinersman.......................... 39

ON HELICITY FLUCTUATIONS AND THE ENERGY CASCADE IN TURBULENCE
C. G. Speziale........................................... 50

COMPUTER TESTS OF RUBBER ELASTICITY
J. H. Weiner and J. Gao.................................. 58

ON THE SAINT–VENANT FLEXURE OF DIATOMIC BARS SUBJECTED TO TERMINAL LOADS
J. L. Nowinski........................................ 64

EFFECT OF NONUNIFORMITY ON EARTHQUAKE RESPONSE OF A SHEAR BEAM STRUCTURE
L. Su and G. Ahmadi.................................... 76

SHEAR BANDS IN ISOTROPIC MICROPOLAR ELASTIC MATERIALS
M. N. L. Narasimhan and M. Kumazawa........................... 84

FINITE ELEMENT ANALYSIS OF ELASTIC–PLASTIC SOLIDS AT LARGE STRAIN
J. D. Lee............................................ 96
ON THE MECHANICS OF INTERFACIAL ZONES IN BONDED MATERIALS
F. Erdogan and P. F. Joseph ........................................... 108

NONLINEAR SURFACE WAVE AND RESONATOR EFFECTS IN MAGNETOSTRICTIVE CRYSTALS
G. A. Maugin ............................................................... 121

THE ELECTROMAGNETIC FIELD AS OSCILLATIONS OF A DEFORMABLE RELATIVISTIC AETHER
A. O. Barut ............................................................... 132

DISLOCATION DYNAMICS IN ANISOTROPIC PIEZOELECTRIC CRYSTALS: INFLUENCE OF THE DISTURBANCE IN THE ELECTRICAL FIELD
S. Minagawa .............................................................. 138

MATERIAL MULTIPOLE MODELLING OF DEFECTS IN ELECTROMAGNETICALLY COUPLED ELASTIC SOLIDS
R. K. T. Hsieh .......................................................... 145

SIMULATION OF ELECTRICALLY ENHANCED FIBROUS FILTRATION
S. Tousi, F. S. Henry, and T. Ariman .................................. 157

A CONSIDERATION OF THE PLASTICITY THEORY OF GRANULAR MATERIALS
M. Satake ................................................................. 170

THE PROPAGATION OF A NORMAL SHOCK IN A VARYING AREA DUCT
A. Suresh ................................................................. 179

A NEW SET OF ORTHOGONAL POLYNOMIALS FOR THE SOLUTION OF ANHARMONIC OSCILLATOR PROBLEMS
N. Arl ................................................................. 188

CERTAIN BASIS FUNCTIONS FOR BIHARMONIC AND LAPLACE’S EQUATIONS AND APPLICATIONS
A. K. Naghdi ............................................................. 198

DYNAMICS OF VISCOELASTIC MEDIA WITH INTERNAL OSCILLATORS
V. N. Nikolaevskii ...................................................... 210

ANALYTICAL MECHANICS OF FRACTURE AND FATIGUE
V. V. Bolotin ............................................................ 222

ON THE POSTCRITICAL BEHAVIOUR OF A CANTILEVER BAR
P. P. Teodorescu and I. Toma ........................................... 233
RELAXED CONFIGURATIONS AND ELASTIC RANGE IN ELASTO-PLASTIC MODELS  
S. Cleja-Tigoiu and E. Soos

THREE-DIMENSIONAL AND FOUR-DIMENSIONAL ASPECTS OF HUMAN PENETRATION AND SUMMARY OF NATURE  
K. Kondo

ON THE BOUNDARY VALUE PROBLEMS IN NONLOCAL ELASTICITY  
S. B. Altan

STABILITY OF FLEXIBLE STRUCTURES WITH RANDOM PARAMETERS  
F. Kozin