

Table of contents

Foreword	IX
Table of contents	XVII
List of contributors	XXI
Scientific life of professor Czesław Woźniak	XXVII
Curriculum Vitae of prof. Czesław Woźniak	XXIX
Publications of prof. Czesław Woźniak	XXXV
Part I. Extensions of constitutive laws	1
1. Constraints as models of bodies possessing non-smooth constitutive characteristics	3
<i>W. Grzesikiewicz, A. Wakulicz, A. Zbiciak</i>	
2. Remodelling of material structure in aortic valve leaflet	19
<i>P. Konderla, K. Patrański</i>	
3. Description of acoustic wave propagation in inhomogeneous materials	35
<i>J. Kubik, M. Cieszko</i>	
4. On some nonconvex problem related to quadratic double-well energy	51
<i>Z. Naniewicz</i>	
5. The identification procedure for the constitutive model of elasto-viscoplasticity describing the behaviour of nanocrystalline iron during quasistatic and dynamic loading processes	63
<i>P. Perzyna, Z. Nowak</i>	
6. Optimal control of elastic continua	89
<i>G. Szefer</i>	
7. Nonlinear thermomechanics of immiscible mixture	99
<i>K. Wilmański</i>	
Part II. Analysis of nonlinear systems	115
8. On the transitions from periodic to chaotic orbits in continual systems	117
<i>J. Awrejcewicz, V.A. Krysko, I.V. Papkova, A.V. Krysko, J. Mrozowski</i>	
9. Problems of modelling in the non-linear stability investigation of thin-walled plated structures.	
Part I – Elastic range	133
<i>Z. Kolakowski</i>	

10. Problems of modelling in the non-linear stability investigation of thin-walled plated structures – Part II – Elasto-plastic range	157
<i>K. Kowal-Michalska</i>	
11. On non-linear shell thermodynamics with interstitial working	181
<i>W. Pietraszkiewicz</i>	
12. Symmetries and constraints in mechanics of continua	195
<i>J.J. Sławianowski</i>	
Part III. Averaging techniques of heterogeneous media	213
13. Dynamics of functionally graded shells – asymptotic and tolerance techniques	215
<i>J. Jędrzyak</i>	
14. Dynamic response of a sheared periodic shear beam with uncertain parameters as a model of high building under fuzzy stochastic excitation	231
<i>K. Mazur-Śniady, P. Śniady</i>	
15. Tolerance modelling of stability of thin plates made of longitudinally graded materials	243
<i>B. Michalak</i>	
16. A simplified tolerance model for heat conduction in periodically laminated media	259
<i>M. Wągrowka</i>	
17. On the influence of boundary layer phenomena onto averaged temperature field	265
<i>E. Wierzbicki</i>	
Part IV. Modelling of microstructured media	275
18. Dynamic thermoelastic processes in microperiodic composites	277
<i>Z. Baczyński</i>	
19. A simplified 2D-model for the elastic response of the transversally-stratified foundation layer	291
<i>E. Baron</i>	
20. Cracks and anticracks in micro-periodic composites – a comparative fracture analysis	299
<i>A. Kaczyński, S. Matysiak</i>	
21. Microlocal modelling of periodic elastic plates	317
<i>W. Nagórko</i>	

22. A combined model for problems of dynamics and stability of biperiodic cylindrical shells	331
<i>B. Tomczyk</i>	
Part V. Thermomechanics of composite materials	357
23. Eigenpairs of systems with random parameters in fracture mechanics	359
<i>J. Drewko</i>	
24. Solutions to the problems of mechanics of non-homogeneous beams and plates	383
<i>G. Jemielita</i>	
25. Fracture of wood under biaxial loading conditions	403
<i>A. Seweryn, M. Romanowicz</i>	
26. The plane-parallel composite strip and the uniform semi-infinite foundation	421
<i>A. Yevtuschenko, M. Kuciej</i>	
Part VI. Numerical methods in structures	435
27. Numerical tests of time-stepping schemes in the context of FEM for 6-field shell dynamics	437
<i>J. Chróścielewski, I. Lubowiecka</i>	
28. Steel-concrete composite beams with elasto-plastic connection	451
<i>M. Kuczma, B. Kuczma</i>	
References	465

Foreword

I consider myself to have been among very fortunate scientists: I have a teacher and friend, Czesław Woźniak, who is the leading scholar in Polish mechanics and applied mathematics and who gave me advices and encouragement to work in science which I indeed made my whole life. He gave me examples how to perform science individually and in a group of coworkers and friends, he gave me the helping hand when I needed it or even when I did not know that I needed it. Most important of all, he taught me that the persistent search for the understanding, insight and precise modelling is in science much more fruitful and important than skills in the use of contemporary fancy techniques and solving of fashionable problems.

Czesław Woźniak was born on 15 March 1931 in Katowice (Poland). He received his Ph.D. in 1961 from the Silesian University of Technology under the supervision of prof. Marian Janusz. Already in the next year he obtained the degree of habilitation for the work “*Aggregate equations of the theory of thin shells*”. From the beginning of his scholar activities he was interested in the application of modern mathematical methods in mechanics and physics. In those years he participated in seminars of the prominent Polish mechanician, prof. Wojciech Urbanowski (IFTR, Warsaw) on nonlinear continuum mechanics and in seminars of the prominent Polish mathematician, prof. Stanisław Gołąb (UJ, Cracow) on differential geometry. In 1964 prof. Czesław Woźniak obtained his first chair of Mechanics of Structures at the Technical University of Łódź. This position has shown that he is not only very talented, open-minded and skillful scientist but also a brilliant teacher and scientific supervisor. The group of his coworkers at the Łódź Technical University experienced unique profits from seminars and self-educational lectures during his tenure in Łódź. I myself learned most of the background knowledge of continuum mechanics with its outgrowth and methods during this time. As the head of various scientific groups I have been trying to mimic his methods but I have never been able to come near his level. Many of his students became then prominent academicians and, as

myself, are trying to implement Woźniak's advices of doing science and teaching. Prof. P. Klemm (Ph.D. in 1967) became the professor of Building Physics of the Łódź Technical University, prof. M. Kleiber (Ph.D. in 1972) became the President of the Polish Academy of Sciences, to name just two examples of the first generation of his Ph.D. students which were almost 30 all together and many of them are professors at various Universities.

He was able to express his very broad and deep knowledge of continuum mechanics and applied mathematics in the form of numerous books. It is only a pity that so many of them were published only in Polish and are therefore not available to the international society of scientists. The first book "*Nonlinear Theory of Shells*" published in 1966 is, without any doubt, the best book on the subject ever written. It is much more general, broader and better formulated than the famous book of P.M. Naghdi, the most quoted book in this field. Even more unique was the next book "*Foundations of dynamics of deformable bodies*" published, again in Polish, in 1969. Variational formulation of continuum mechanics was at that time very unusual and many questions, solved by means of this method, such as invariance and conservation principles, Noether Theorem, nonlocal interactions, scale effects and many others, are still actual and important. The next following book "*Lattice surface structures*" was published in 1970. This is even more the exemplification of Woźniak's outstanding mind. The book contains continuous modelling of numerous discrete structures such as grits, plates with ribs, etc. The results go far beyond the usual modelling by anisotropic continua known at that time. The book contains both strategies of a micro-macro transition needed for such models as well as relations to generalized continua of the Cosserat type. It is a true mine of engineering and mathematical problems, important for practical applications and interesting from the theoretical point of view. Its essential extension and mathematically different and systematic approach - tolerance averaging approach - is still the main field of research of Czesław Woźniak. In the same year, 1970, he published together with prof. Zbigniew Wesółowski a book "*Foundations of nonlinear elasticity theory*". This beautiful book is not large, 104 pages, and it should be an obligatory literature for all young people who work within continuum mechanics. Of course, the book was published in Polish. Let me name another book, published in 1988 by Ossolineum, certainly in Polish as well, on constraints in continua "*Constraints in mechanics of deformable*

bodies”. This is a wonderful piece of work on the subject which is still very lively in contemporary science. It contains results which are mostly unknown even to experts in this field.

In collaboration with his student, prof. M. Kleiber, prof. Woźniak published two unique books on mechanics of structures. The first one in Polish “*Nonlinear mechanics of structures*” appeared in 1982 and then, published by Kluwer in 1991 the book of the same title but entirely different contents. It contains foundations, transitions to various engineering simplified models and an introduction to numerical methods which is the specialty of prof. Kleiber.

Fortunately, one of the most successful contributions of Czesław Woźniak to mechanics, averaging techniques with the help of the notion of tolerance, was published already in English (the first book, written together with prof. Ewaryst Wierzbicki, appeared in 2000). This idea, according to the claims of prof. Woźniak, has grown up from discussions with the famous Italian mathematician Gaetano Fichera. It very well can be that prof. Fichera directed prof. Woźniak’s expositions on the mathematical subject of nonstandard analysis which lies in the foundations of this new technique – jauntily speaking, how to approximate “zero” - but the merit for the full development of the model should, certainly, solely belong to prof. Woźniak. The field still develops very vehemently and yields quite unexpected results such as the variational derivation of parabolic equations for, for instance, heat conduction. The present book contains many examples of the applications of this novel approach to the problem of averaging. To get the flavour and to appreciate the extent of applicability of the approach one should realize that it is used to describe almost all solids and structures with a deterministic microstructure (inclusions, layers, fibres, ribs, etc.) and it is concurrent to the older homogenization technique. In contrast to the latter it is nonasymptotic and its fundamental concept of the tolerance relation has much better and clearer physical roots.

Most of the numerous new scientific results of prof. Woźniak were published in renowned scientific journals. He published some 300 papers and, due to his current scientific activities, the list is far from being closed.

However, it may not be a bad idea to undertake a big job of translating in English all these Polish books which I have mentioned above and publishing them as the monumental Collected Works. It would be certainly a tribute to the exceptional mind of prof. Czesław Woźniak but it would be also a stimulation

for many young researchers in the field of continuum mechanics and applied mathematics.

A short but very successful period of occupation at the Technical University of Łódź and the subsequent collaboration with this University was recognized by awarding prof. Woźniak the Honorary Doctorate of this University in 1988. The employment in Łódź was followed by the professorship at the Warsaw University, initiated by the outstanding Polish mechanician, prof. Witold Nowacki. This position and the position of the Head of the Research Group of Composites at the Institute of Fundamental Technological Research of the Polish Academy of Sciences fulfilled the work and research period of prof. Woźniak in Warsaw. Since 1996 to 2001 he held the chair at the Technical University of Częstochowa (Poland). Again, in spite of a relatively short duration of this position, he is so successful as the scientist and teacher that the University awarded him with the Honorary Doctorate in 2007.

In addition to his activities in Poland he visited for a longer time various scientific institutions in the world. One should name the Italian Universities of Piza, Udine, La Sapienza in Rome, l'Aquila, Glasgow in Scotland, Aachen and Bochum in Germany, Beijing in China. He was making there the research but also teaching graduate courses and writing books.

His retirement went almost unnoticed as prof. Woźniak remains active until today at Universities of Częstochowa and Łódź, he is organizing conferences, for instance, the very successful series of meetings on "Mechanics of Inhomogeneous Media" held in Łagów (Poland), he is a member of Scientific Societies and Editorial Committees of international scientific journals.

The present book contains contributions of his friends, coworkers and students, who want in this way express their gratitude for his devotion to teaching and supervising them, who want to express the admiration for his outstanding skills and contributions to science in general and to thermomechanics in particular. All contributions to the book are related to the research fields in which prof. Woźniak was doing research himself and in many cases pointed out important directions of search for new results. Here is the list of those fields

- 1) averaging techniques in thermomechanics,
- 2) thermomechanics of composites and porous materials,
- 3) theories of shells,

4) applications of a concept of constraints in thermomechanical problems of composites and structures,

5) homogenization modelling of periodic media using macrolocal parameters,

6) averaging modelling of microheterogeneous media in the framework of the tolerance averaging technique.

Honorable Professor Woźniak, dear Czesiu! On the occasion of the celebration of Your 80th Birthday we wish You many further very successful years of live and many new contributions to the science of thermomechanics.

Krzysztof Wilmański

Łódź, 15 March 2011

PS. I am very grateful to colleagues for attributing me the task of writing this Foreword the reason being that I have a honour of being the first Ph.D. student of prof. Woźniak (1965). However, I have to mention that the majority of editorial work was done by prof. Jarosław Jędrysiak and prof. Bohdan Michalak of the Technical University of Łódź.