A USEFUL STUDY OF DIFFERENCE EQUATIONS – FROM THEORETICAL AND PRACTICAL POINTS OF VIEW

Review of the volume *Ecuații cu diferențe și scheme de calcul* by Gh. Anton and Gh. Radu, Editura Academiei Forțelor Aeriene "Henri Coandă", 2016

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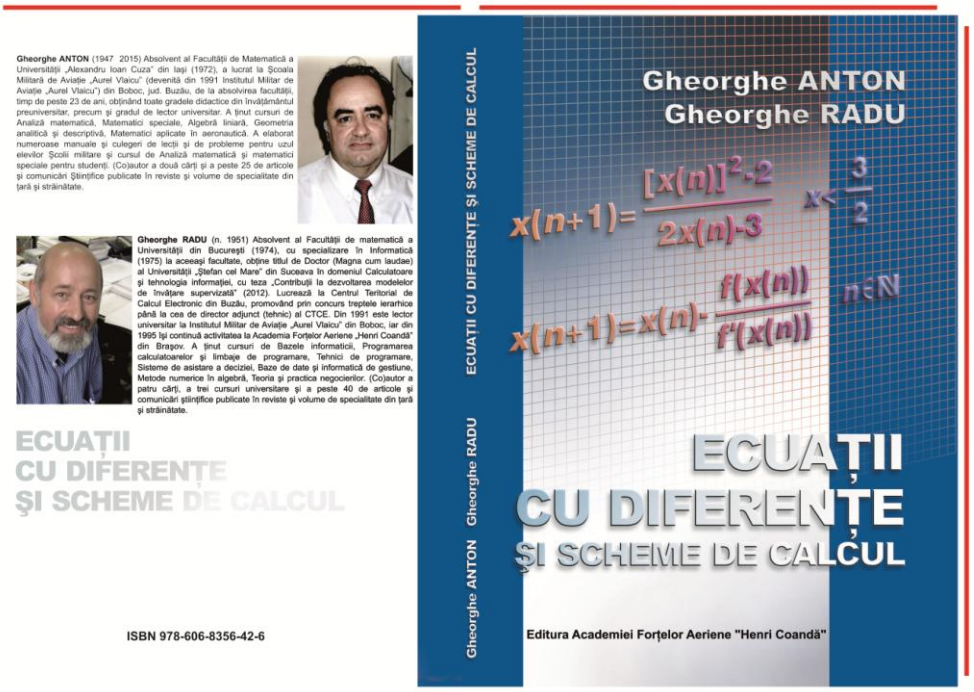

Due to the amazing rate of growing of computer science, the theory of difference equations, used to numerically approximate and to obtain properties of solutions for various kinds of differential equations, has received much attention in the last decades.

Thus, the idea of elaborating of a comprehensive material on this subject, containing the basic notions related to difference equations, is more than welcome.

Besides, for the beginners in the field and not only, putting, together with theoretical elements, of a section concerning a large number of applications to different branches of elementary and advanced mathematics, of computer science and many other areas makes the subject of this book even more interesting.

Combining their teaching and research experience, the authors provide a well organized, pedagogical approach, although many theoretical results are only stated without proof given the amplitude of the theory and the large number of notions taken into consideration.

The material is divided into two main sections: theory, respectively applications.

The first chapter, entitled "Ecuații cu diferențe", introduces the difference and antidifference operators, gives their basic properties and examples, then presents Cauchy problems and problems with conditions at the boundary associated to difference equations.

Afterwards, the authors focus on classical methods as well as on operational methods, based on MacLaurin or Z transforms, for solving linear (or reducible to linear) difference equations. In this part, the discussion is given in full detail, with definitions, proofs and tables of properties together with useful examples.

The next part of this chapter is concerned with the matter of stability for dynamical systems; namely, different types of stability are obtained for linear difference equations and also for nonlinear such equations.

A list of solved problems and a number of problems proposed to the reader ends this theoretical section.

Chapter 2 represents, in the opinion of the reviewer, the strong point of the book. It contains applications of the theory previously described to a large number of practical problems.

For example, elementary exercises containing recurrences for sequences of real numbers can be solved in a very elegant manner by regarding them as difference equations and applying specific methods (such as, operational methods).

Also, the problem of calculating powers of square matrices reduces to the solving of appropriate difference equations.

A whole subchapter is devoted to an interesting application to the novel theory of automatic voice recognition using Fourier transform. It can be seen from the study developed in this part that the calculus of Mel Frequency cepstral coefficients can be reduced to the solving of a difference equation. Moreover, these coefficients can be calculated more accurately with this method comparing to classical methods (such as, Linear Predictive Coding).

Of special practical importance, coming from the remark that ODEs are an essential feature in the mathematical modeling, is the discussion concerning the solving of ODEs via numerical schemes that lead to difference equations (see also [3]). Such numerical schemes are described and also their convergence, stability and the precision of the obtained approximation are rigorously studied.

Therefore, the case of ODEs with impulses at preassigned moments (which are, in fact, a mix between differential equations and difference equations) can also be studied through the theory of difference equations. Here the general theoretical results are only recalled from literature ([1]), emphasis being then put on the framework of linear differential equations with impulses where numerical schemes are detailed. It seems worthwhile to notice that impulsive problems occur in a huge number of fields (such as, biology, automatics, electronics and so on, see [2]).

The second chapter ends in the same (pedagogical) manner: with a list of solved or proposed to be solved exercises.

To conclude, the book under review has got all the premises to become a very useful tool for students in engineering, at master or PhD level, but also for researchers working in applied mathematics and related fields.

REFERENCES

[1] D. Bainov, P. Simionov, *Impulsive Differential Equations, Periodic Solutions and Applications*, Monographs Applied Mathematics, vol. 66, Langman Scientific Technical, John Wiley & Sons Inc., New-York, 1993.

[2] A.N. Sesekin, S.T. Zavalishchin, *Dynamic Impulse Systems*, Dordrecht, Kluwer Academic (1997).

[3] C.I. Gheorghiu, *Metode numerice pentru sisteme dinamice*, Casa cărții de știință, Cluj-Napoca, 2006.