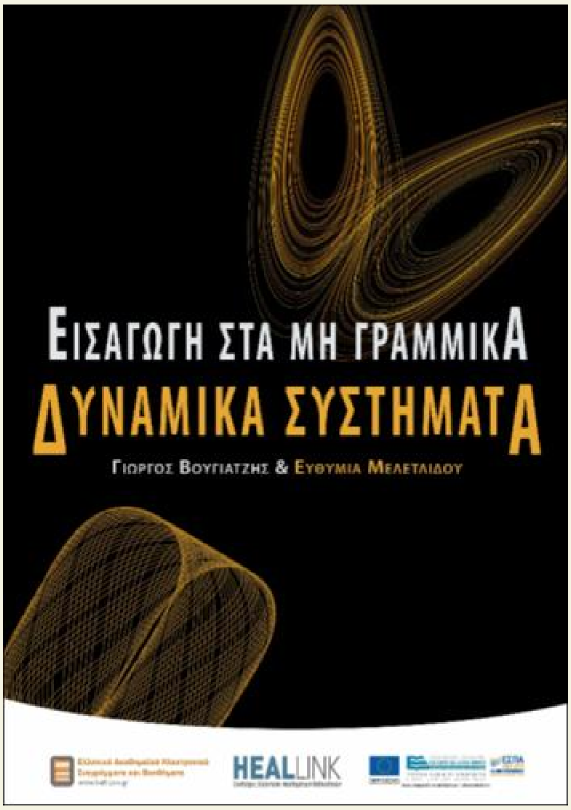

METADATA

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Abstract

This book serves as an introduction to the study of Nonlinear Systems and is aimed at third- and fourth-year undergraduate students in the Physical Sciences or Engineering. It could also be used as a basis for a corresponding course in a Graduate Studies Program. The book's goal is to help students understand the basic methods used in dynamical systems, their limitations, the concept of stability, and the necessary conditions for complex behavior to occur. Since the analytical mathematical approach to a dynamical system is generally difficult for an undergraduate student, we focus on computational techniques. We use Mathematica (or the free software Mathics), which combines analytical and numerical calculations as well as graphics in an easy manner. The book initially deals with simple mechanical systems and more generally with autonomous continuous systems in two dimensions. The basic points of dynamics, such as equilibrium points, stability, characteristics of phase space topology, bifurcations, periodic solutions, and limit cycles, are described in detail. These characteristics are mainly described computationally for three-dimensional systems as well. For non-autonomous systems, we limit ourselves to one dimension and oscillator systems with external periodic disturbance. The possible behavioral cases (periodic or quasi-periodic oscillations, limit cycles, chaotic behavior) are described. The second part of the book refers to discrete systems in one and two dimensions. We study their fixed and periodic points as well as their linear stability. Through classic systems (such as the logistic map), we demonstrate the transition from order to chaos and provide the property of chaos with a rigorous mathematical definition. Finally, we present the Smale horseshoe mapping and the creation of the homoclinic tangle in conservative mappings.

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