Book reviews

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Mathematics — the Music of Reason

(Translation from the French original: Pour l'honeur de l'esprit human, 1987, by H. G. and J. C. Dales.)

Springer–Verlag, Berlin – Heidelberg – New York – London – Paris 1992.
290 pages; 41 figures; ISBN 3-540-53346-X.

By tradition the oracle in Delph recommended a king whose daughter was ill and sad: "Teach her mathematics and music". The well known French mathematician, author of the referred book, expressed the similarity of those two branches of human mental activity in even stronger way. The title of the book is to reflect the feature of abstract harmony which is common for the seemingly so distant disciplines. The book is devoted for a reader who is interested in science but not a professional mathematician. It should be noted that, even not being a mathematician, the reader has to be familiar with a relatively wide class of mathematical notions and symbols including the basic concepts of calculus or matrix theory.

The author presents and discusses many concepts and methods of classical and modern mathematics to illustrate the development of mathematical thinking, its inherent balancedness and proportionality.

In contrary to the development of natural sciences, mathematics step by step coded its essentially natural concepts into rather hermetic symbols and terms of its specific language. The problems arising in the "classical" mathematics (the author uses this word generally for mathematics before 1800) in connection with its endeavour to describe the features of the real world motivated the discovery of high-level abstraction typical for the modern mathematical branches. The main goal of the referred book is to show and explain the roots of these modern abstractions and their relations to both – the concepts of traditional mathematics and the demands of the adequate description of real complex phenomena.

The book is divided into six main chapters, each of which is structuralized into numerous sections and subsections. The first two chapters titled "Mathematics and Mathematicians" and "The Nature of Mathematical Problems" are devoted to the position of mathematics and mathematicians in the contemporary world including the links between mathematics and other sciences. They practically do not contain any formulas or other elements of the mathematical hermetics.

The third chapter "Objects and Methods of Classical Mathematics" offers a brief survey of mathematical thinking "of Euclid to Gauss" including the elements of metamathematics (like the notions of axioms, proofs etc.) and the evolution of the concepts of geometry, numbers, algebra, approximation, coordinates and infinitesimal calculus. Even the fourth chapter "Some Problems of Classical Mathematics" deals with the traditional mathematics, namely with the roots of problems which gave rise to important research of the last two centuries. Among numerous topics of that nature the author elected the problems of perfect numbers, Fermat numbers, the four-color problem, the elementary geometry structures (which he refers as intractable and sterile), and the problems of sums of squares, prime numbers and algebraic geometry as representatives of the prolific ones.

The most extensive and most important is the next fifth chapter. It is titled "New Objects and New Methods", and it aims to illustrate the path from the analysis of the existing "classical" problems to the discovery of their nature and to discovering of their (partial or complete) solution. It also shows that the price to be paid for this success is the necessity of abandoning the more or less vivid or partially concrete objects of the classical mathematics and creating new abstract concepts reflecting the essential relations or similarities among them. Six sections of this chapter are subjected to the "New Calculations"

(complex numbers, vectors, permutations, substitutions, congruences, etc.), "The First Structures" (laws of composition, groups of transformations, abstract groups, quaternions, algebras), "The Language of Sets and General Structures" (sets, algebraic structures, orderings, metric and topological spaces etc.), "Isomorphisms and Classifications" (besides the concepts mentioned in the heading also functors and structures), and the last two descriptive brief sections "Mathematics of Our Day" and "Intuition and Structures" which present a panorama of modern mathematical branches and conceptual approaches to their development.

The last chapter "Problems and Pseudo-Problems About 'Foundations"' offers a view on the endeavour of (mostly 19th century) mathematicians for the complete formal precision.

Except the first two ones all remaining chapters are completed by Appendices intended for a more detailed (and more accurate) presentation of some selected topics useful for more advanced readers. The book is completed by a Historical Index, survey of standard notations and Index of Terminology.

The referred book belongs to those ones which offer an interesting and useful view on the general philosophy of contemporary mathematics. In this sense it can be useful not only for non-mathematical but in mathematics interested readers. Also mathematicians and mathematically active engineers can find interesting to consider the routine concepts and procedures in their historical and mathematical context.

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Robust Multivariable Feedback Control

Akademie-Verlag and Prentice-Hall, Berlin – London 1988.
X + 237 pages.

The monograph is an introduction to the theory of robust feedback control which is supplied by practical examples and outlining the main lines of current research. It consists of Preface, Introduction, 12 Chapters, 3 Appendices, References, Symbols and Subject Index. Chapter 1 (The Problem of Robust Control) presents the main problems arising in robustness analysis and feedback control design. Chapter 2 (Fundamental Results from Feedback Theory) surveys standard results of linear continuous time deterministic system theory without considering uncertainties. Chapter 3 (Sensitivity of Feedback Systems) surveys sensitivity analysis of feedback systems and explains clearly the concepts of sensitivity and robustness. Chapter 4 (A Survey of the Methods for Analysing and Designing Uncertain Feedback Systems) surveys the known principles for analysing uncertain systems and classifies the results into qualitative and quantitative robustness issues. In Chapter 5 (Models of Uncertain Systems) an approximate model and an error model are distinguished as a general structure for uncertain system models. Special cases of the general structure are presented with an emphasis on systems with unknown-but-bounded uncertainties. Chapter 6 (Qualitative Robustness Analysis and Design) presents the stability margins and the stability degrees as robustness indicators including the way for their improvement by feedback. Methods based on singular perturbations and high-gain feedback are considered here. Algebraic aspects of robustness by means of a graph topology are mentioned. Chapter 7 (Simultaneous Stabilization and Pole Assignment) summarizes quantitative robustness investigations for a finite discrete set of completely specified models, where the distance between the models may be large. The problem is to stabilize all systems of the set by means of a single controller. Chapter 8 (Quantitative Robustness of Systems

with Bounded Uncertainties) presents the method by Horowitz, analyses the robustness of MIMO systems subject to unknown-but-bounded uncertainties, presents frequency domain stability criteria and time domain criteria for robust I/O-stability including analysis of the I/O-performance. Finally, the design of robust feedback controller is summarized. Stabilizability under matching conditions for state space model is considered. Chapter 9 (Controller Design by means of Approximate Model) considers the design of a Smith predictor controller and the design using a low frequency pass prefilter in the closed-loop. Chapter 10 (Robust Multivariable PI-Controllers) presents PI-controller design for MIMO systems with integrity property. Existence and stability conditions are given. PI-controlled boiler and chemical process examples are included. In Chapter 11 (Robust Decentralized Control) existence conditions for decentralized PI-controller are given. The design of decentralized controller using generalized diagonal dominance of transfer functions is presented. An example of the design of decentralized voltage controller in interconnected electric power systems is included. Chapter 12 (Trends in Robust Feedback Control) outlines some recent research directions in robust multivariable feedback control. In Appendices nonnegative and M-matrices, singular value decomposition and the Nichols chart are described.

The book is a useful survey of the methods for analysing and designing robust controllers for linear time invariant continuous time deterministic systems. It has a character of clearly written introductory textbook in this field supposing some knowledge in linear control theory and matrix calculus, and including the author's original results. Numerous references are given with bibliographical notes at the end of each chapter. Though it is mentioned that only the first appearance of any published result used in the book is included in references, the reference to some of them is missing.

References

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[2] M. Morari and E. Zafiriou: Robust Process Control. Prentice-Hall, London 1989.

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