

Preface

Our intention in preparing this book was to present in as simple a manner as possible those branches of error analysis which find direct applications in solving various problems in engineering practice. The main reason for writing this text was the lack of such an approach in existing books dealing with the error calculus. Most of books are devoted to mathematical statistics and to probability theory. The range of applications is usually limited to the problems of general statistics and to the analysis of errors in various measuring techniques.

Much less attention is paid in these books to two-dimensional and three-dimensional distributions, and almost no attention is given to problems connected with the two-dimensional and three-dimensional vectorial functions of independent random variables. The theory of such vectorial functions finds new applications connected, for example, with analysis of the positioning accuracy of various mechanisms, among them of robot manipulators and automatically controlled earth-moving and loading machines, such as excavators.

Besides basic information concerning classical simple applications of error calculus, a substantial part of the book is devoted to new aspects of more advanced problems along with numerous examples of practical applications in engineering practice. Among others, the Mohr circles representation of tensors is used for transformation of the components of covariance tensors, for determination of linear regression, for analysis of the accuracy of artillery fire, and for analysis of the positioning accuracy of various mechanisms. Methods of determination of the ellipses and ellipsoids of probability concentration have been described in detail, along with examples of practical calculations.

Chapters 1, 2, 3 and 4 contain a presentation of the fundamentals of error calculus: basic characteristics of error distributions, histograms and their various applications, basic continuous distributions of errors and functions of independent random variables. In Chap. 5, two-dimensional distributions of errors are discussed with applications to analysis of the accuracy of artillery fire, to the determination of linear regression for sets of experimental points, and to the calculation of correlation coefficients. Fundamentals of the theory of two-dimensional continuous independent and dependent random variables are also discussed in that chapter. Then the methods of determination of the ellipses of probability concentration for a two-dimensional continuous normal distribution are given.

Chapter 6 deals with the two-dimensional vectorial functions of independent random variables along with practical applications to analysis of the positioning accuracy of mechanisms with two-dimensional movements. The procedure of determination of ellipses of probability concentration is also described.

In Chap. 7, three-dimensional distributions of errors are considered, while Chap. 8 deals with three-dimensional vectorial functions of independent random variables. The theory is illustrated by examples of analysis of the positioning accuracy of robot manipulators. Examples of determining the ellipsoids of probability concentration are presented.

Chapter 9 consists of basic information connected with calculation of probabilities that functions of independent random variables satisfy specific inequalities. Such problems are inherent in the theory of reliability of engineering structures and, on the other hand, are a natural generalization of the traditional error calculus.

The concluding Chap. 10 gives introductory material for future studies in application of more advanced probability theory in engineering. It also contains bibliographical remarks for future studies and extended references.

This book has been written for readers whose main interests are applications of error calculus in various problems of engineering. We have indicated that certain important concepts of that calculus such as, for example, variance and covariance, are notionally analogous to the concepts of inertia moments of plane or solid figures. The standard deviation is analogous to the so-called inertia radius of such figures. The procedure for calculating such values is analogous to that of determination of the centers of gravity of plane or solid figures.

In the first nine chapters much attention is paid to the practical significance of error analysis. However, some additional information concerning its mathematical foundations has been included in this book. It may be omitted by readers who are mainly interested in applications of error calculus.

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