
Preface

The aim of this book is to provide, firstly, an introduction to probability and statistics especially directed to the metrology and testing fields and secondly, a comprehensive, newer set of modelling methods for data and uncertainty analysis that are generally not considered yet within mainstream methods. The book brings, for the first time, a coherent account of these newer methods and their computational implementation. They are potentially important because they address problems in application fields where the usual hypotheses that are at the basis of most of the traditional statistical and probabilistic methods, for example, relating to normality of the probability distributions, are frequently not fulfilled to such an extent that an accurate treatment of the calibration or test data using standard approaches is not possible. Additionally, the methods can represent alternative ways of data analysis, allowing a deeper understanding of complex situations in measurement. The book lends itself as a possible textbook for undergraduate or postgraduate study in an area where existing texts focus mainly on the most common and well-known methods that do not encompass modern approaches to calibration and testing problems.

The book is structured in such a way to guide readers with only a general interest in measurement issues through a series of review papers, from an initial introduction to modelling principles in metrology and testing, to the basic principles of probability in metrology and statistical approaches to uncertainty assessment. Later chapters provide a survey of the newer methods, from an introduction to the alternative approach of interval mathematics to the latest developments in data analysis using least squares, FFT, wavelets, and fuzzy methods; from data fusion (including decision taking and risk analysis), to tools for combining data of complex statistical structure; and from uncertainty issues related to model imperfection, to those related to combining testing data. The book also includes chapters on modern computational issues related to measurement: a computer-assisted simplified rigorous approach to data evaluation, an analysis of the strategies to adopt for measurement software validation, an introduction to the virtual instrument approach, and an

overview of the main IT applications in metrology. The book does not concentrate on any particular field of application, because the applications in the frames of metrology and testing cover so broad a range that it would be difficult to make a ranking of their importance or even to attempt a grouping into categories with homogeneous needs. On the other hand, most of the various techniques illustrated in the chapters of the book can find application to many different issues related to these application fields.

A DVD is attached to the book, containing software for free use (under the specified conditions), ranging from tutorials to sample codes of the implementation of methods described in the book, to software packages with demos of methods and tools, allowing the reader to try to see especially the newer tools at work with the minimum effort, without the need of implementing his or her own code.

The authors are mainly selected from an international collaborative framework (<http://www.imeko-tc21.org>, <http://www.imeko.org>), established in the early 1990s as ‘AMCTM’ (<http://www.amctm.org>), that has allowed a community of metrologists, mathematicians, statisticians, and software/IT engineers to work together, so creating a common understanding of the issues discussed in this book.

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