Book Review

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Engineering Uncertainty and Risk Analysis, Second Edition: A Balanced Approach to Probability, Statistics, Stochastic Modelling, and Stochastic Differential Equations
by: Sergio E. Serrano
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Engineering uncertainty and risk analysis presents an introduction to the broad field of engineering uncertainty analysis in one comprehensive coverage. The author offers an integrated description of the subjects of probability, statistics, Monte Carlo simulation, descriptive and inferential statistics, design of experiments, systems reliability, fitting models to random data, analysis of variance (ANOVA), stochastic processes, and stochastic differential equations. The focus is on engineering applications, rather than theoretical or mathematical considerations. Each concept is illustrated with several examples (177 solved examples) of relevance in engineering applications (no cards, coloured balls, or dice). The emphasis is on clarity and the author succeeded in presenting a consistent notation and SI units throughout. This second edition is completely revised and includes many new research advances in non-linear stochastic equations; new simple methods to solve and graph boundary-value problems in several dimensions without the need of perturbation, or complex traditional analytical or numerical techniques. This book will be of interest to undergraduate and graduate students, but also to professional engineers wishing to review the subjects of uncertainty analysis in one comprehensive text. Because of the inclusion of new advances in non-linear stochastic analysis, the book may prove invaluable to research engineers.

This is one of the few books that present the subject of random differential equations in a practical way with many engineering examples. One of the most difficult problems in risk analysis is the solution of engineering systems governed differential equations when one or more of its parameters are defined in statistical terms. The author presents the topic in a readable fashion of interest to the applied engineer, beginning with simple examples of ordinary differential equations subject to random initial conditions, then moving onto the case of differential equations subject to random forcing terms, and random parameters. The reader is then exposed to cases of stochastic boundary-value problems, and finally to non-linear random equations. Many examples in environmental engineering and heat transfer are shown in simple details along with short computer programmes.

Of particular interest to research engineers is the inclusion of recent research developments in non-linear science and simulation. The book introduces new meshless, analytical decomposition, and variational iteration techniques to solve non-linear ordinary and partial differential equations. For instance, the method of decomposition of Adomian exhibits the benefits of analytical solutions (i.e., stability, analytic derivation of heads, gradients, fluxes, simple programming). It also offers the advantages of traditional numerical methods (i.e., consideration of media heterogeneity, irregular domain shapes, multiple dimensions). In addition, decomposition is one of the few systematic procedures to solve non-linear equations. By far, its greatest advantage is its simplicity of application. It may produce simple results for preliminary simulations or in cases with scarce information. The author describes the method with simple applications to the solution of boundary-value problems in engineering. Many step-by-step analytical derivations and simple numerical examples are included along with computer programmes: Simple models of non-linear stochastic boundary-value initial-value problems in multiple dimensions, heterogeneous media, and irregular domains; systematic methods to consider mathematical non-linearity; the consideration of heterogeneity; the modelling of irregularly-shaped domains, the inclusion of multiple sources; and the analysis of transients.

A standard mathematics software (Maple) is employed as a general analytical and numerical computing platform in risk assessment. Many modelling applications which previously required specialised software are now included. However, there is no need of prior knowledge of the software since the book gradually introduces the reader to its use through many applications beginning in the first chapter. Thus, the reader learns Maple programming easily by running the simple programmes presented in the first chapters, and gradually becomes proficient with the software and its functions in the latter chapters. The reader is shown how to construct very short programmes to solve equations, calculate gradients and plot contours, directional arrows of fluxes, and three-dimensional heads without the need of specialised software. This is an additional advantage of the book, since Maple is one of the most widely used mathematics and numerical software available today.

Some features of the book include a consistent SI notation, 478 pages, softbound, 177 solved examples, 147 proposed problems, 174 illustrations, 69 short computer programmes, and 51 data and statistical tables.