Experimentation Validation And Uncertainty Analysis For Engineers

Experimentation, Validation, and Uncertainty Analysis for EngineersJohn Wiley & Sons

This Third Edition helps you assess and manage uncertainty at all stages of experimentation and validation of simulations In this greatly expanded Third Edition, the acclaimed Experimentation, Validation, and Uncertainty Analysis for Engineers guides readers through the concepts of experimental uncertainty analysis and the applications in validating models and simulations, solving problems experimentally, and characterizing the behavior of systems. This Third Edition presents the current, internationally accepted methodology from ISO, ANSI, and ASME standards to cover the planning, design, debugging, and execution phases of experiments. Cases in which the experimental result is determined only once or when the result is determined multiple times in a test are addressed and illustrated with examples from the authors' experience. The important practical cases in which multiple measured variables share correlated errors are discussed in detail, and strategies to take advantage of such effects in calibrations and comparative testing situations are presented. The methodology for determining uncertainty by Monte Carlo analysis is described in detail. Knowledge of the material in this Third Edition is a must for those involved in executing or managing experimental programs or validating models, codes, and simulations. Professionals and students in disciplines spanning the full range of engineering and science will find this book an essential guide.

Now, in the only manual available with direct applications to the design and analysis of engineering experiments, respected authors Hugh Coleman and Glenn Steele have thoroughly updated their bestselling title to include the new methodologies being used by the United States and International standards committee groups.

The Concise Encyclopedia of Environmental Systems provides a concise overview of the current state of the art in the study of environmental systems. Contains specially commissioned articles and updated and revised articles from the acclaimed Systems & Control Encyclopedia. The subjects covered include: agricultural systems; atmospheric processes and air quality; ecosystems; environmental chemistry; geology, soil processes and geophysics; hydrology, fluid dynamics and water quality; marine processes; meteorology; and climatology. In addition, many of the articles cover the methodological procedures used in environmental systems analysis, with contributions on automatic control and management; computers in modelling and management; environmental planning; environmetric methods, including time-series analysis; mathematical modelling, including data-based, physically based and simulation modelling; remote sensing and image processing; uncertainty in environmental systems; and sensitivity analysis. The encyclopedia is extensively cross-referenced on two levels - to articles of direct relevance as well as to other articles which will provide the reader with more general background information.

This text constitutes proceedings from the International Symposium on Microelectronics that took place in Boston, Massachusetts in September, 2000.

KEY BENEFIT: An up-to-date, practical introduction to engineering experimentation. Introduction to Engineering Experimentation, 3E introduces many topics that engineers need to master in order to plan, design, and document a successful experiment or measurement system. The text offers a practical approach with current examples and thorough discussions of key topics, including those often ignored or merely touched upon by other texts, such as modern computerized data acquisition systems, electrical output measuring devices, and in-depth coverage of experimental uncertainty analysis. The book includes theoretical coverage and selected applications of statistics and probability, instrument dynamic response, uncertainty analysis and Fourier analysis; detailed descriptions of computerized data acquisition systems and system components, as well as a wide range of common sensors and measurement systems such as strain gages and thermocouples. Worked examples are provided for theoretical topics and sources of uncertainty are presented for measurement systems. For engineering professionals looking for an up-to-date, practical introduction to the field of engineering experimentation.

This unique volume introduces and discusses the methods of validating computer simulations in scientific research. The core concepts, strategies, and techniques of validation are explained by an international team of pre-eminent authorities, drawing on expertise from various fields ranging from engineering and the physical sciences to the social sciences and history. The work also offers new and original philosophical perspectives on the validation of simulations. Topics and features: introduces the fundamental concepts and principles related to the validation of computer simulations, and examines philosophical frameworks for thinking about validation; provides an overview of the various strategies and techniques available for validating simulations, as well as the preparatory steps that have to be taken prior to validation; describes commonly used reference points and mathematical frameworks applicable to simulation validation; reviews the legal prescriptions, and the administrative and procedural activities related to simulation validation; presents examples of best practice that demonstrate how methods of validation are applied in various disciplines and with different types of simulation models; covers important practical challenges faced by simulation scientists when applying validation methods and techniques; offers a selection of general philosophical reflections that explore the significance of validation from a broader perspective. This truly interdisciplinary handbook will appeal to a broad audience, from professional scientists spanning all natural and social sciences, to young scholars new to research with computer simulations. Philosophers of science, and methodologists seeking to increase their understanding of simulation validation, will also find much to benefit from in the text.

Computational modeling allows to reduce, refine and replace animal experimentation as well as to translate findings obtained in these experiments to the human background. However these biomedical problems are inherently complex with a myriad of influencing factors, which strongly complicates the model building and validation process. This book wants to address four main issues related to the building and validation of computational models of biomedical processes: 1. Modeling establishment under uncertainty 2. Model selection and parameter fitting 3. Sensitivity analysis and model adaptation 4. Model predictions under uncertainty In each of the abovementioned areas, the book discusses a number of key-techniques by means of a general theoretical description followed by one or more practical examples. This book is intended for graduate students and researchers active in the field of computational modeling of biomedical processes who seek to acquaint themselves with the different ways in which to study the parameter space of their model as well as its overall behavior.

This book explores the evolution of products from the beginning idea through mass-production. Rather than prescribing a one-size-fits-all process, the authors explain the theory behind product development and challenge readers to develop their own customized development process uniquely suited for their individual situation. In addition to theory, the book provides development case studies, exercises and self-evaluation criteria at the end of each chapter, and a product development reference that introduces a wide variety of design tools and methods. Class-tested for three consecutive years by hundreds of students in four different courses, the book is an ideal text for senior design classes in mechanical engineering and related disciplines as well as a reference for practicing engineers/product designers.

This book constitutes the proceedings of the 12th IFIP TC 8 International Conference, CISIM 2013, held in Cracow, Poland, in September 2013. The 44 papers presented in this volume were carefully reviewed and selected from over 60 submissions. They are organized in topical sections on biometric and biomedical applications; pattern recognition and image processing; various aspects of computer security, networking, algorithms, and industrial applications. The book also contains full papers of a keynote speech and the invited talk.

The purpose of this document is to identify some suggested types of experiments that can be performed in the Advanced Test Reactor Critical (ATR-C) facility. A fundamental computational investigation is provided to demonstrate possible integration of experimental activities in the ATR-C with the development of benchmark experiments. Criticality benchmarks performed in the ATR-C could provide integral data for key matrix and structural materials used in nuclear systems. Results would then be utilized in the improvement of nuclear data libraries and as a means for analytical methods validation. It is proposed that experiments consisting of well-characterized quantities of materials be placed in the Northwest flux trap position of the ATR-C. The reactivity worth of the material could be determined and computationally analyzed through comprehensive benchmark activities including uncertainty analyses. Experiments were modeled in the available benchmark model of the ATR using MCNP5 with the ENDF/B-VII.0 cross section library. A single bar (9.5 cm long, 0.5 cm wide, and 121.92 cm high) of each material could provide sufficient reactivity difference in the core geometry for computational modeling and analysis. However, to provide increased opportunity for the validation of computational models, additional bars of material placed in the flux trap would increase the effective reactivity up to a limit of 1$ insertion. For simplicity in assembly manufacture, approximately four bars of material could provide a means for additional experimental benchmark configurations, except in the case of strong neutron absorbers and many materials providing positive reactivity. Future tasks include the cost analysis and development of the experimental assemblies, including means for the characterization of the neutron flux and spectral indices. Oscillation techniques may also serve to provide additional means for experimentation and validation of computational methods and acquisition of integral data for improving neutron cross sections. Further assessment of oscillation techniques for implementation in the ATR-C may be of additional benefit. The establishment of benchmark experiment capabilities in the ATR-C would allow for the further development of techniques and facility enhancements involving neutronics experimentation in the ATR-C.

Advances in scientific computing have made modelling and simulation an important part of the decision-making process in engineering, science, and public policy. This book provides a comprehensive and systematic development of the basic concepts, principles, and procedures for verification and validation of models and simulations. The emphasis is placed on models that are described by partial differential and integral equations and the simulations that result from their numerical solution. The methods described can be applied to a wide range of technical fields, from the physical sciences, engineering and technology and industry, through to environmental regulations and safety, product and plant safety, financial investing, and governmental regulations. This book will be genuinely welcomed by researchers, practitioners, and decision makers in a broad range of fields, who seek to improve the credibility and reliability of simulation results. It will also be appropriate either for university courses or for independent study.

Advances in computing hardware and algorithms have dramatically improved the ability to simulate complex processes computationally. Today's simulation capabilities offer the prospect of addressing questions that in the past could be addressed only by resource-intensive experimentation, if at all. Assessing the Reliability of Complex Models recognizes the ubiquity of uncertainty in computational estimates of reality and the necessity for its quantification. As computational science and engineering have matured, the process of quantifying or bounding uncertainties in a computational estimate of a physical quality of interest has evolved into a small set of interdependent tasks: verification, validation, and uncertainty of quantification (VVUQ). In recognition of the increasing importance of computational simulation and the increasing need to assess uncertainties in computational results, the National Research Council was asked to study the mathematical foundations of VVUQ and to recommend steps that will ultimately lead to improved processes. Assessing the Reliability of Complex Models discusses changes in education of professionals and dissemination of information that should enhance the ability of future VVUQ practitioners to improve and properly apply VVUQ methodologies to difficult problems, enhance the ability of VVUQ customers to understand VVUQ results and use them to make informed decisions, and enhance the ability of all VVUQ stakeholders to communicate with each other. This report is an essential resource for all decision and policy makers in the field, students, stakeholders, UQ experts, and VVUQ educators and practitioners.

Each volume contains proceedings of the annual conference of the American Nuclear Society.

This highly practical handbook is an exhaustive treatment of eddy covariance measurement that will be of keen interest to scientists who are not necessarily specialists in micrometeorology. The chapters cover measuring fluxes using eddy covariance technique, from the tower installation and system dimensioning to data collection, correction and analysis. With a state-of-the-art perspective, the authors examine the latest techniques and address the most up-to-date methods for data processing and quality control. The

chapters provide answers to data treatment problems including data filtering, footprint analysis, data gap filling, uncertainty evaluation, and flux separation, among others. The authors cover the application of measurement techniques in different ecosystems such as forest, crops, grassland, wetland, lakes and rivers, and urban areas, highlighting peculiarities, specific practices and methods to be considered. The book also covers what to do when you have all your data, summarizing the objectives of a database as well as using case studies of the CarboEurope and FLUXNET databases to demonstrate the way they should be maintained and managed. Policies for data use, exchange and publication are also discussed and proposed. This one compendium is a valuable source of information on eddy covariance measurement that allows readers to make rational and relevant choices in positioning, dimensioning, installing and maintaining an eddy covariance site; collecting, treating, correcting and analyzing eddy covariance data; and scaling up eddy flux measurements to annual scale and evaluating their uncertainty.

Helps engineers and scientists assess and manage uncertainty at all stages of experimentation and validation of simulations Fully updated from its previous edition, Experimentation, Validation, and Uncertainty Analysis for Engineers, Fourth Edition includes expanded coverage and new examples of applying the Monte Carlo Method (MCM) in performing uncertainty analyses. Presenting the current, internationally accepted methodology from ISO, ANSI, and ASME standards for propagating uncertainties using both the MCM and the Taylor Series Method (TSM), it provides a logical approach to experimentation and validation through the application of uncertainty analysis in the planning, design, construction, debugging, execution, data analysis, and reporting phases of experimental and validation programs. It also illustrates how to use a spreadsheet approach to apply the MCM and the TSM, based on the authors' experience in applying uncertainty analysis in complex, large-scale testing of real engineering systems. Experimentation, Validation, and Uncertainty Analysis for Engineers, Fourth Edition includes examples throughout, contains end of chapter problems, and is accompanied by the authors' website www.uncertainty-analysis.com. Guides readers through all aspects of experimentation, validation, and uncertainty analysis Emphasizes the use of the Monte Carlo Method in performing uncertainty analysis Includes complete new examples throughout Features workable problems at the end of chapters Experimentation, Validation, and Uncertainty Analysis for Engineers, Fourth Edition is an ideal text and guide for researchers, engineers, and graduate and senior undergraduate students in engineering and science disciplines. Knowledge of the material in this Fourth Edition is a must for those involved in executing or managing experimental programs or validating models and simulations.

The project proposed to provide a Predictive Maturity Framework with its companion metrics that (1) introduce a formalized, quantitative means to communicate information between interested parties, (2) provide scientifically dependable means to claim completion of Validation and Uncertainty Quantification (VU) activities, and (3) guide the decision makers in the allocation of Nuclear Energy's resources for code development and physical experiments. The project team proposed to develop this framework based on two complimentary criteria: (1) the extent of experimental evidence available for the calibration of simulation models and (2) the sophistication of the physics incorporated in simulation models. The proposed framework is capable of quantifying the interaction between the required number of physical experiments and degree of physics sophistication. The project team has developed this framework and implemented it with a multi-scale model for simulating creep of a core reactor cladding. The multi-scale model is composed of the viscoplastic self-consistent (VPSC) code at the meso-scale, which represents the visco-plastic behavior and changing properties of a highly anisotropic material and a Finite Element (FE) code at the macro-scale to represent the elastic behavior and apply the loading. The framework developed takes advantage of the transparency provided by partitioned analysis, where independent constituent codes are coupled in an iterative manner. This transparency allows model developers to better understand and remedy the source of biases and uncertainties, whether they stem from the constituents or the coupling interface by exploiting separate-effect experiments conducted within the constituent domain and integral-effect experiments conducted within the full-system domain. The project team has implemented this procedure with the multi- scale VPSC-FE model and demonstrated its ability to improve the predictive capability of the model. Within this framework, the project team has focused on optimizing resource allocation for improving numerical models through further code development and experimentation. Related to further code development, we have developed a code prioritization index (CPI) for coupled numerical models. CPI is implemented to effectively improve the predictive capability of the coupled model by increasing the sophistication of constituent codes. In relation to designing new experiments, we investigated the information gained by the addition of each new experiment used for calibration and bias correction of a simulation model. Additionally, the variability of 'information gain' through the design domain has been investigated in order to identify the experiment settings where maximum information gain occurs and thus guide the experimenters in the selection of the experiment settings. This idea was extended to evaluate the information gain from each experiment can be improved by intelligently selecting the experiments, leading to the development of the Batch Sequential Design (BSD) technique. Additionally, we evaluated the importance of sufficiently exploring the domain of applicability in experiment-based validation of high-consequence modeling and simulation by developing a new metric to quantify coverage. This metric has also been incorporated into the design of new experiments. Finally, we have proposed a data-aware calibration approach for the calibration of numerical models. This new method considers the complexity of a numerical model (the number of parameters to be calibrated, parameter uncertainty, and form of the model) and seeks to identify the number of experiments necessary to calibrate the model based on the level of sophistication of the physics. The final component in the project team's work to improve model calibration and validation methods is the incorporation of robustness to non-probabilistic uncertainty in the input parameters. This is an improvement to model validation and uncerta ...

Uncertainties are inevitable in any experimental measurement. Therefore, it is essential for science and engineering graduates to design and develop reliable experiments and estimate the uncertainty in the measurements. This book describes the methods and application of uncertainty analysis during the planning, data analysis, and reporting stages of an experiment. This book is aimed at postgraduate and advanced undergraduate students of various branches of science and engineering. The book teaches methods for estimating random and systematic uncertainties and combining them to determine the overall uncertainty in a measurement. In addition, the method for propagating measurement uncertainties in the calculated result is discussed. The book also discusses methods of reducing the uncertainties through proper instrumentation, data acquisition, and experiment planning. This book provides detailed background and assumptions underlying the uncertainty analysis techniques for the reader to understand their applicability. Various solved examples are provided to demonstrate the application of the uncertainty analysis techniques. The exercises at the end of the chapters have been chosen carefully to reinforce the concepts discussed in the text.

The articles in The Encyclopedia of Medical Devices and Instrumentation focus on what is currently useful or is likely to be useful in future medicine. They answer the question, What are the branches of medicine and how does technology assist each of them? Articles focus on the practice of medicine that is assisted by devices, rather than including, for example, the use of drugs to treat disease. The title is the only resource on the market dealing with the subject in encyclopedic detail. * Accessible to practitioners with a broad range of backgrounds from students to researchers and physicians * Articles cover the latest developments such as nanotechnology, fiber optics, and signal processing

The high cost of experimentation and product development in the field of microelectromechanical systems (MEMS) has led to a greater emphasis on simulation-based design for increasing first-pass design

success and reliability. The use of compliant or flexible mechanisms can help eliminate friction, wear, and backlash, but compliant MEMS are sensitive to variations in material properties and geometry. This dissertation proposes approaches for design stage uncertainty analysis, model validation, and robust optimization of nonlinear compliant MEMS to account for critical process uncertainties including residual stress, layer thicknesses, edge bias, and material stiffness. Methods for simulating and mitigating the effects of non-idealities such joint clearances, semi-rigid supports, non-ideal loading, and asymmetry are also presented. Approaches are demonstrated and experimentally validated using bistable micromechanisms and thermal microactuators as examples.

Model Validation and Uncertainty Quantifi cation, Volume 3. Proceedings of the 34th IMAC, A Conference and Exposition on Dynamics of Multiphysical Systems: From Active Materials to Vibroacoustics, 2016, the third volume of ten from the Conference brings together contributions to this important area of research and engineering. Th e collection presents early findings and case studies on fundamental and applied aspects of Structural Dynamics, including papers on: • Uncertainty Quantifi cation & Model Validation • Uncertainty Propagation in Structural Dynamics • Bayesian & Markov Chain Monte Carlo Methods • Practical Applications of MVUQ • Advances in MVUQ & Model Updating • Robustness in Design & Validation • Verifi cation & Validation Methods

Introduction to Statistical Analysis of Laboratory Data presents a detailed discussion of important statistical concepts and methods of data presentation and analysis Provides detailed discussions on statistical applications including a comprehensive package of statistical tools that are specific to the laboratory experiment process Introduces terminology used in many applications such as the interpretation of assay design and validation as well as “fit for purpose” procedures including real world examples Includes a rigorous review of statistical quality control procedures in laboratory methodologies and influences on capabilities Presents methodologies used in the areas such as method comparison procedures, limit and bias detection, outlier analysis and detecting sources of variation Analysis of robustness and ruggedness including multivariate influences on response are introduced to account for controllable/uncontrollable laboratory conditions