Chemometrics Based Process Analytical Technology Pat

Process Analytical Technology explores the concepts of PAT and its application in the chemical and pharmaceutical industry from the point of view of the analytical chemist. In this new edition all of the original chapters have been updated and revised, and new chapters covering the important topics of sampling, NMR, fluorescence, and acoustic chemometrics have been added. Coverage includes: Implementation of Process Analytical Technologies UV-Visible Spectroscopy for On-line Analysis Infrared Spectroscopy for Process Analytical Applications Process Raman Spectroscopy Process NMR Spectroscopy: Technology and On-line Applications Fluorescent Sensing and Process Analytical Applications Chemometrics in Process Analytical Technology (PAT) On-Line PAT Applications of Spectroscopy in the Pharmaceutical Industry Future Trends for PAT for Increased Process Understanding and Growing Applications in Biomanufacturing NIR Chemical Imaging This volume is an important starting point for anyone wanting to implement PAT and is intended not only to assist a newcomer to the field but also to provide up-to-date information for those who practice process analytical chemistry and PAT. It is relevant for chemists, chemical and process engineers, and analytical chemists working on process development, scale-up and production in the pharmaceutical, fine and specialty chemicals industries, as well as for academic chemistry, chemical engineering, chemometrics and pharmaceutical science research groups focussing on PAT. Review from the First Edition “The book provides an excellent first port of call for anyone seeking material and discussions to understand the area better. It deserves to be found in every library that serves those who are active in the field of Process Analytical Technology.”—Current Engineering Practice

This book is a structured approach to designing a product and its associated manufacturing process. It shows pharmaceutical engineers and scientists involved in product and process development how to utilize QbD practices and applications effectively while complying with government regulations. Material includes discussion of how to utilize design space, models, process control methodology, and cumulative process knowledge to seek improvements in manufacturing, while maintaining and enhancing product performance. Edited by three renowned researchers in the field, this invaluable resource is an essential tool for all pharmaceutical professionals.

Authoritative guide to the principles, characteristics, engineering aspects, economics, and applications of disposables in the manufacture of biopharmaceuticals The revised and updated second edition of Single-Use Technology in Biopharmaceutical Manufacture offers a comprehensive examination of the most-commonly used disposables in the manufacture of biopharmaceuticals. The authors—noted experts on the topic—provide the essential information on the principles, characteristics, engineering aspects, economics, and applications. This authoritative guide contains the basic knowledge and information about disposable equipment. The author also discusses biopharmaceuticals’ applications through the lens of case studies that clearly illustrate the role of manufacturing, quality assurance, and environmental influences. This updated second edition revises existing information with recent developments that have taken place since the first edition was published. The book also presents the latest advances in the field of single-use technology and explores topics including applying single-use devices for microorganisms, human mesenchymal stem cells, and T-cells. This important book: • Contains an updated and end-to-end view of the development and manufacturing of single-use biologics • Helps in the identification of appropriate disposables and relevant vendors • Offers illustrative case studies that examine manufacturing, quality assurance, and environmental influences • Includes updated coverage on cross-functional/transversal dependencies, significant improvements made by suppliers, and the successful application of the single-use technologies Written for biopharmaceutical manufacturers, process developers, and biological and chemical engineers, Single-Use Technology in Biopharmaceutical Manufacture, 2nd Edition provides the information needed for professionals to come to an easier decision for or against disposable alternatives and to choose the appropriate system.

Mathematical and Statistical Approaches in Food Science and Technology offers an accessible guide to applying statistical and mathematical technologies in the food science field whilst also addressing the theoretical foundations. Using clear examples and case-studies by way of practical illustration, the book is more than just a theoretical guide for non-statisticians, and may therefore be used by scientists, students and food industry professionals at different levels and with varying degrees of statistical skill. Food biotechnology’s typical developments and applications have occurred in the fields of genetics and in enzyme- and cell-based biological processes, with the goal of producing and improving food ingredients and foods themselves. While these developments and applications are usually well reported in terms of the underlying science, there is a clear lack of information on the engineering aspects of such biotechnology-based food processes. Filling this gap, Engineering Aspects of Food Biotechnology provides a comprehensive review of those aspects, from the development of food processes and products to the most important unit operations implied in food biotechnological processes, also including food quality control and waste management. The book focuses on the use of biotechnology for the production of ingredients to be used in the food industry. It addresses two relevant issues—consumer’s awareness of the relation between nutrition and good health and the importance of environmental sustainability in the food chain (i.e. production of polymers and in vitro meat). A chapter on the application of process analytical technology highlights the importance of this tool for satisfying the increasingly sophisticated and strict polices for quality control and monitoring of specific process phases. The book includes a detailed presentation of relevant unit operations developed to extract/purify the ingredients of biotechnological origin intended for food applications. In addition to examining the contributions of biotechnology to producing and improving food ingredients, the book provides a concise description of the role biotechnology plays in adding value to food processing by-products, including post-harvest losses, in relevant industries of the food sector. It builds a foundation for further research and development in the food processing industry.
Chromatography approaches are widely used in various life science applications. Since its invention by the Russian botanist Mikhail S. Tsvet in 1901, chromatography has increasingly developed into an invaluable laboratory tool for the separation and identification of chemical components. It outperforms older techniques (such as crystallization, solvent extraction, and distillation) by offering unequaled resolving power and the possibility of lowering detection limits to below nanogram levels. To further improve chromatographic methods, however, the use of chemometrics is advisable as an economical alternative to resolve any problematic situations in analysis. This book intends to provide the readers with an up-to-date application of chemometrics and data analysis to different types of chromatographic methods.

Advances and Challenges in Pharmaceutical Technology: Materials, Process Development and Drug Delivery Strategies examines recent advancements in pharmaceutical technology. The book discusses common formulation strategies, including the use of tools for statistical formulation optimization. Quality by design (QbD), process analytical technology, and the uses of various pharmaceutical biomaterials, including natural polymers, synthetic polymers, modified natural polymers, bioceramics, and other bioinorganics. In addition, the book covers rapid advancements in the field by providing a thorough understanding of pharmaceutical processes, formulation developments, explorations, and exploitation of various pharmaceutical biomaterials to formulate pharmaceutical dosage forms. Provides extensive information and analysis on recent advancements in the field of pharmaceutical technology. Includes contributions from global leaders and experts in academia, industry and regulatory agencies. Uses high quality illustrations, flow charts and tables to explain concepts and text to readers, along with practical examples and research case studies.

Written for industrial and academic researchers and development scientists in the life sciences industry, Bioprocessing Technology for Production of Biopharmaceuticals and Bioproducts is a guide to the tools, approaches, and useful developments in bioprocessing. This important guide: • Summarizes state-of-the-art bioprocessing methods and reviews applications in life science industries • Includes illustrative case studies that review six milestone bio-products • Discusses a wide selection of host strain types and disruptive bioprocess technologies.

A comprehensive look at existing technologies and processes for continuous manufacturing of pharmaceuticals. As rising costs outpace new drug development, the pharmaceutical industry has come under intense pressure to improve the efficiency of its manufacturing processes. Continuous process manufacturing provides a proven solution. Among its many benefits are: minimized waste, energy consumption, and raw material use; the accelerated introduction of new drugs; the use of smaller production facilities with lower building and capital costs; the ability to monitor drug quality on a continuous basis; and enhanced process reliability and flexibility. Continuous Manufacturing of Pharmaceuticals prepares professionals to take advantage of that exciting new approach to improving drug manufacturing efficiency. This book covers key aspects of the continuous manufacturing of pharmaceuticals. The first part provides an overview of key chemical engineering principles and the current regulatory environment. The second covers existing technologies for manufacturing both small-molecule-based products and protein/peptide products. The following section is devoted to process analytical tools for continuously operating manufacturing environments. The final two sections treat the integration of several individual parts of processing into fully operating continuous process systems and summarize state-of-art approaches for innovative new manufacturing principles. Brings together the essential know-how for anyone working in drug manufacturing, as well as chemical, food, and pharmaceutical scientists working on continuous processing. Covers chemical engineering principles, regulatory aspects, primary and secondary manufacturing, process analytical technology and quality-by-design. Contains contributions from researchers in leading pharmaceutical companies, the FDA, and academic institutions. Offers an extremely well-informed look at the most promising future approaches to continuous manufacturing of innovative pharmaceutical products. Timely, comprehensive, and authoritative, Continuous Manufacturing of Pharmaceuticals is an important professional resource for researchers in industry and academic working in the fields of pharmaceuticals development and manufacturing.

To understand the world around us, as well as ourselves, we need to measure many things, many variables, many properties of the systems and processes we investigate. Hence, data collected in science, technology, and almost everywhere else are multivariate, a data table with multiple variables measured on multiple observations (cases, samples, items, process time points, experiments). This book describes a remarkably simple minimalistic and practical approach to the analysis of data tables (multivariate data). The approach is based on projection methods, which are PCA (principal components analysis), and PLS (projection to latent structures) and the book shows how this works in science and technology for a wide variety of applications. In particular, it is shown how the great information content in well collected multivariate data can be expressed in terms of simple but illuminating plots, facilitating the understanding and interpretation of the data. The projection approach applies to a variety of data-analytical objectives, i.e., (i) summarizing and visualizing a data set, (ii) multivariate classification and discriminant analysis, and (iii) finding quantitative relationships among the variables. This works with any shape of data table, with many or few variables (columns), many or few observations (rows), and complete or incomplete data tables (missing data). In particular, projections handle data matrices with more variables than observations very well, and the data can be noisy and highly collinear. Authors: The five authors are all connected to the Umetrics company (www.umetrics.com) which has developed and sold software for multivariate analysis since 1987, as well as supports customers with training and consultations. Umetrics’ customers include most large and medium sized companies in the pharmaceutical, biopharm, chemical, and semiconductor sectors. This book is devoted to new developments in measurement technologies for upstream and downstream bioprocessing. The recent advances in biotechnology and bioprocessing have generated a number of new biological products that require more qualified analytical technologies for diverse process analytical needs. These includes especially fast and
sensitive measurement technology that, early in the process train, can inform on critical process parameters related to process economy and product quality and that can facilitate ambitions of designing efficient integrated end-to-end bioprocesses. This book covers these topics as well as analytical monitoring methods based either on real-time or in-line sensor technology, on simple and compact bioanalytical devices, or on the use of advanced data prediction methods.

For more than four decades, scientists and researchers have relied on the Advances in Chromatography series for the most up-to-date information on a wide range of developments in chromatographic methods and applications. Volume 44 of this authoritative series once again compiles the work of expert contributors in order to present timely and cutting-edge reviews on a variety of related topics. Each author's clear presentation of topics and vivid illustrations make the material in Advances in Chromatography: Volume 44 accessible and engaging to biochemists and analytical, organic, polymer, and pharmaceutical chemists at all levels of technical skill.

Process analytical chemistry (PAC) can be defined as the technology of obtaining quantitative and qualitative information about a chemical process in order to control or optimise its performance. This highly practical book provides an up-to-date introduction to the field with a special emphasis placed on industrial processes. Edited by representatives from one of the world's leading chemical companies and centres of excellence for research into the subject, the book is written by a transatlantic team of authors who provide a global perspective.

The book presents developments and applications of these methods, such as NMR, mass, and others, including their applications in pharmaceutical and biomedical analyses. The book is divided into two sections. The first section covers spectroscopic methods, their applications, and their significance as characterization tools; the second section is dedicated to the applications of spectrophotometric methods in pharmaceutical and biomedical analyses. This book would be useful for students, scholars, and scientists engaged in synthesis, analyses, and applications of materials/polymers.

Process Analytical Technology: Spectroscopic Tools and Implementation Strategies for the Chemical and Pharmaceutical Industries
John Wiley & Sons

The ultimate goal of drug product development is to design a system that maximizes the therapeutic potential of the drug substance and facilitates its access to patients.

Pharmaceutical Dosage Forms: Tablets, Third Edition is a comprehensive resource of the design, formulation, manufacture, and evaluation of the tablet dosage form, an area of active research and development. This book provides a concise overview of the subject and serves as a reference for both new and seasoned practitioners.

Forensic Chemistry: Fundamentals and Applications presents a new approach to the study of applications of chemistry to forensic science. It is edited by one of the leading forensic scientists with each chapter written by international experts specializing in their respective fields, and presents the applications of chemistry, especially analytical chemistry, to various topics that make up the forensic scientists' toolkit. This comprehensive, textbook includes in-depth coverage of the major topics in forensic chemistry including: illicit drugs, fibers, fire and explosive residues, soils, glass and paints, the chemistry of fingerprint recovery on porous surfaces, the chemistry of firearms analysis, as well as two chapters on the key tools of forensic science, microscopy and chemometrics. Each topic is explored at an advanced college level, with an emphasis, throughout the text, on the use of chemical tools in evidence analysis. Forensic Chemistry: Fundamentals and Applications is essential reading for advanced students of forensic science and analytical chemistry, as well as forensic science practitioners, researchers and faculty, and anyone who wants to learn about the fascinating subject of forensic chemistry in some depth. This book is published as part of the AAFS series 'Forensic Science in Focus'.

Of all things natural, light is the most sublime. From the very existential belief of the origins of the universe to its role in the evolution of life on earth, light has been inextricably woven into every aspect of our lives. I am grateful to Springer-Verlag and Thomas Schepers for this invitation to organize this volume that continues to expand the use of light to create next generation sensing applications. Indeed, the very act of expanding the frontiers of learning and knowledge are referred to in many languages and cultures as enlightenment. Early optical instruments relied largely on simple combinations of mirrors, prisms and lenses. With these simple devices, substantial progress was made in our understanding of the properties of light and of its interactions with matter. Things got more complicated with the evolution of optical instruments in labour-intensive use. Early systems used bulky and expensive hardware to generate light, split it into the desired wavelengths and finally collect it for analysis. The discovery of the laser pushed the technology further, but did not do much to make its adoption more widespread as the lasers themselves were large and required substantial electrical power to operate. The true revolution is just beginning. Advances in micronics have resulted in the possibility of truly low-cost (using the consumer electronics industry as a parallel) devices that exploit optical measurement technology.

Comprehensive Chemometrics, Second Edition features expanded and updated coverage, along with new content that covers advances in the field since the previous edition.
published in 2009. Subject of note include updates in the fields of multidimensional and megavariate data analysis, omics data analysis, big chemical and biochemical data analysis, data fusion and sparse methods. The book follows a similar structure to the previous edition, using the same section titles to frame articles. Many chapters from the previous edition are updated, but there are also many new chapters on the latest developments. Presents integrated reviews of each chemical and biological method, examining their merits and limitations through practical examples and extensive visuals Bridges a gap in knowledge, covering developments in the field since the first edition published in 2009 Meticulously organized, with articles split into 4 sections and 12 sub-sections on key topics to allow students, researchers and professionals to find relevant information quickly and easily Written by academics and practitioners from various fields and regions to ensure that the knowledge within is easily understood and applicable to a large audience Presents integrated reviews of each chemical and biological method, examining their merits and limitations through practical examples and extensive visuals Bridges a gap in knowledge, covering developments in the field since the first edition published in 2009 Meticulously organized, with articles split into 4 sections and 12 sub-sections on key topics to allow students, researchers and professionals to find relevant information quickly and easily Written by academics and practitioners from various fields and regions to ensure that the knowledge within is easily understood and applicable to a large audience

Chemometrics is the application of mathematics and statistics to chemical data in order to design or select optimal experimental procedures, to provide maximum relevant information, and to obtain knowledge about systems under study. This chemical discipline has constantly developed to become a mature field of Analytical Chemistry after its inception in the 1970s. The utility and versatility of chemometric techniques enable spectroscopists to perform multidimensional classification and/or calibration of spectral data that make identification and quantification of analytes in complex mixtures possible. Wavelets are mathematical functions that cut up data into different frequency components, and then study each component with a resolution matched to its scale. They are now being adapted for a vast number of signal processing due to their unprecedented success in terms of asymptotic optimality, spatial adaptivity and computational efficiency. In analytical chemistry, they have increasingly shown great applicability and have been preferred over existing signal processing algorithms in noise removal, resolution enhancement, data compression and chemometrics modeling in chemical studies. The aim of this Research Topic is to present state-of-the-art applications of chemometrics, in the field of spectroscopy, with special attention to the use of wavelet transform. Both reviews and original research articles on pharmaceutical and biomedical analysis are welcome in the specialty section Analytical Chemistry.

Using formal descriptions, graphical illustrations, practical examples, and R software tools, Introduction to Multivariate Statistical Analysis in Chemometrics presents simple yet thorough explanations of the most important multivariate statistical methods for analyzing chemical data. It includes discussions of various statistical methods, such as principal component analysis, regression analysis, classification methods, and clustering. Written by a chemometrician and a statistician, the book reflects the practical approach of chemometrics and the more formally oriented one of statistics. To enable a better understanding of the statistical methods, the authors apply them to real data examples from chemistry. They also examine results of the different methods, comparing traditional approaches with their robust counterparts. In addition, the authors use the freely available R package to implement methods, encouraging readers to go through the examples and adapt the procedures to their own problems. Focusing on the practicality of the methods and the validity of the results, this book offers concise mathematical descriptions of many multivariate methods and employs graphical schemes to visualize key concepts. It effectively imparts a basic understanding of how to apply statistical methods to multivariate scientific data.

This chapter provides a basic theoretical background on chemometrics and chemometric methods for the analysis of multivariate data. Multivariate data analysis is essential for both product and process development and optimization. Depending on the problem studied, classification and/or regression multivariate methods are applied for data analysis. Different supervised and unsupervised methods for classification and regression are presented, followed by examples of their application in pharmaceutical technology. Some of the methods described include principal component analysis, various supervised classification methods, multiple linear regression, principal component regression, partial least squares regression, support vector machines, etc.

This book provides knowledge of the basic theory, spectral analysis methods, chemometrics, instrumentation, and applications of near-infrared (NIR) spectroscopy—not as a handbook but rather as a sourcebook of NIR spectroscopy. Thus, some emphasis is placed on the description of basic knowledge that is important in learning and using NIR spectroscopy. The book also deals with applications for a variety of research fields that are very useful for a wide range of readers from graduate students to scientists and engineers in both academia and industry. For readers who are novices in NIR spectroscopy, this book provides a good introduction, and for those who already are familiar with the field it affords an excellent means of strengthening their knowledge about NIR spectroscopy and keeping abreast of recent developments. This book offers readers an accessible introduction to the world of multivariate statistics in the life sciences, providing a comprehensive description of the general data analysis paradigm, from exploratory analysis (principal component analysis, self-organizing maps and clustering) to modeling (classification, regression) and validation (including variable selection). It also includes a special section discussing several more specific topics in the area of chemometrics, such as outlier detection, and biomarker identification. The corresponding R code is provided for all the examples in the book; and scripts, functions and data are available in a separate R package. This second revised edition features not only updates on many of the topics covered, but also several sections of new material (e.g., on handling missing values in PCA, multivariate process monitoring and batch correction).

This edited book presents the recent developments in partial least squares-path modeling (PLS-PM) and provides a comprehensive overview of the current state of the most advanced research related to PLS-PM. The first section of this book emphasizes the basic concepts and extensions of the PLS-PM method. The second section discusses the methodological issues that are the focus of the recent development.
of the PLS-PM method. The third part discusses the real world application of the PLS-PM method in various disciplines. The contributions from expert authors in the field of PLS focus on topics such as the factor-based PLS-PM, the perfect match between a model and a mode, quantile composite-based path modeling (QC-PM), ordinal consistent partial least squares (OrdPLSc), non-symmetrical composite-based path modeling (NSCPM), modern view for mediation analysis in PLS-PM, a multi-method approach for identifying and treating unobserved heterogeneity, multigroup analysis (PLS-MGA), the assessment of the common method bias, non-metric PLS with categorical indicators, evaluation of the efficiency and accuracy of model misspecification and bootstrap parameter recovery in PLS-PM, CB-SEM, and the Bollen-Stine methods and importance-performance map analysis (IPMA) for nonlinear relationships. This book will be useful for researchers and practitioners interested in the latest advances in PLS-PM as well as master and Ph.D. students in a variety of disciplines using the PLS-PM method for their projects.

The Process Analytical Technology (PAT) initiative aims to move from a paradigm of 'testing quality in' to 'building quality in by design'. It can be defined as the optimal application of process analytical technologies, feedback process control strategies, information management tools, and/or product-process optimization strategies. Recently, there have been significant advances in process sensors and in model-based monitoring and control methodologies, leading to enormous opportunities for improved performance of food manufacturing processes and for the quality of food products with the adoption of PAT. Improvements in process efficiency, reduced product variability, enhanced traceability, process understanding, and decreased risk of contamination are some of the benefits arising from the introduction of a PAT strategy in the food industry. Process Analytical Technology for the Food Industry reviews established and emerging PAT tools with potential application within the food processing industry. The book will also serve as a reference for industry, researchers, educators, and students by providing a comprehensive insight into the objectives, challenges, and benefits of adopting a Process Analytical Technology strategy in the food industry.

Multivariate Analysis in the Pharmaceutical Industry provides industry practitioners with guidance on multivariate data methods and their applications over the lifecycle of a pharmaceutical product, from process development to manufacturing. It outlines how to ensure an environment that follows Good Manufacturing Practice (GMP) Examines recent developments and suggests future directions for drug production methods and techniques.

Process Systems Engineering for Pharmaceutical Manufacturing: From Product Design to Enterprise-Wide Decisions, Volume 41, covers the following process systems engineering methods and tools for the modernization of the pharmaceutical industry: computer-aided pharmaceutical product design and pharmaceutical production processes design/synthesis; modeling and simulation of the pharmaceutical processing unit operation, integrated flowsheets and applications for design, analysis, risk assessment, sensitivity analysis, optimization, design space identification and control system design; optimal operation, control and monitoring of pharmaceutical production processes; enterprise-wide optimization and supply chain management for pharmaceutical manufacturing processes. Currently, pharmaceutical companies are going through a paradigm shift, from traditional manufacturing mode to modernized mode, built on cutting edge technology and computer-aided methods and tools. Such shifts can benefit tremendously from the application of methods and tools of process systems engineering. Introduces Process System Engineering (PSE) methods and tools for discovering, developing and deploying greener, safer, cost-effective and efficient pharmaceutical production processes. Includes a wide spectrum of case studies where different PSE tools and methods are used to improve various pharmaceutical production processes with distinct final products. Examines the future benefits and challenges for applying PSE methods and tools to pharmaceutical manufacturing.

The Future of Pharmaceutical Product Development and Research examines the latest developments in the pharmaceutical sciences, also highlighting key developments, research and future opportunities. Written by experts in the field, this volume in the Advances in Pharmaceutical Product Development and Research series deepens our understanding of the product development phase of drug discovery and development. Each chapter covers fundamental principles, advanced methodologies and technologies employed by pharmaceutical scientists, researchers and the pharmaceutical industry. The book focuses on excipients, radiopharmaceuticals, and how manufacturing should be conducted in an environment that follows Good Manufacturing Practice (GMP) guidelines. Researchers and students will find this book to be a comprehensive resource for those new to the field and an invaluable reference for those working in industry.

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Program Analysis in the Pharmaceutical Industry provides industry practitioners with guidance on multivariate data methods and their applications over the lifecycle of a pharmaceutical product, from process development to manufacturing.

Difficult sampling and tedious off-line analyzes.

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Green chemistry and chemical engineering belong together and this twelth volume in the successful Handbook of Green Chemistry series represents the perfect one-stop reference on the topic. Written by an international team of specialists with each section edited by international leading experts, this book provides first-hand insights into the field, covering chemical engineering process design, innovations in unit operations and manufacturing, biorefining and much more besides. An indispensable source for every chemical engineer in industry and academia.

In processing food, hyperspectral imaging, combined with intelligent software, enables digital sorters (or optical sorters) to identify and remove defects and foreign material that are invisible to traditional camera and laser sorters. Hyperspectral Imaging Analysis and Applications for Food Quality explores the theoretical and practical issues associated with the development, analysis, and application of essential image processing algorithms in order to exploit hyperspectral imaging for food quality evaluations. It outlines strategies and essential image processing routines that are necessary for making the appropriate decision during detection, classification, identification, quantification, and/or prediction processes. Features Covers practical issues associated with the development, analysis, and application of essential image processing for food quality applications Surveys the breadth of different image processing approaches adopted over the years in attempting to implement hyperspectral imaging for food quality monitoring Explains the working principles of hyperspectral systems as well as the basic concept and structure of hyperspectral data Describes the different approaches used during image acquisition, data collection, and visualization The book is divided into three sections. Section I discusses the fundamentals of Imaging Systems: How can hyperspectral image cube acquisition be optimized? Also, two chapters deal with image segmentation, data extraction, and treatment. Seven chapters comprise Section II, which deals with Chemometrics. One explains the fundamentals of multivariate analysis and techniques while in six other chapters the reader will find information on and applications of a number of chemometric techniques: principal component analysis, partial least squares analysis, linear discriminant model, support vector machines, decision trees, and artificial neural networks. In the last section, Applications, numerous examples are given of applications of hyperspectral imaging systems in fish, meat, fruits, vegetables, medicinal herbs, dairy products, beverages, and food additives.

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