Mckelvey Semiconductor Physics

This text presents the basic physical properties of crystalline solids and device structures such as p-n junctions and quantum wells. Emphasis is on simple explanations of basic physical theory and application rather than a detailed analysis of complex devices and fabrication technology.

In addition to the topics discussed in the First Edition, this Second Edition contains introductory treatments of superconducting materials and of ferromagnetism. I think the book is now more balanced because it is divided perhaps 60% - 40% between devices (of all kinds) and materials (of all kinds). For the physicist interested in solid state applications, I suggest that this ratio is reasonable. I have also rewritten a number of sections in the interest of (hopefully) increased clarity. The aims remain those stated in the Preface to the First Edition; the book is a survey of the physics of a number of solid state devices and ma terials. Since my object is a discussion of the basic ideas in a number of fields, I have not tried to present the "state of the art," especially in semi conductor devices. Applied solid state physics is too vast and rapidly changing to cover completely, and there are many references available to recent developments. For these reasons, I have not treated a number of interesting areas. Among the lacunae are superiattices, heterostructures, compound semiconductor devices, ballistic transistors, integrated optics, and light wave communications. (Suggested references to those subjects are given in an appendix.) I have tried to cover some of the recent revolutionary developments in superconducting materials.

The technological progress is closely related to the developments of various materials and tools made of those materials. Even the different ages have been defined in relation to the materials used. Some of the major attributes of the present-day age (i.e., the electronic materials' age) are such common tools as computers and fiber-optic telecommunication systems, in which semiconductor materials provide vital components for various mic- electronic and optoelectronic devices in applications such as computing, memory storage, and communication. The field of semiconductors encompasses a variety of disciplines. This book is not intended to provide a comprehensive description of a wide range of semiconductor properties or of a continually increasing number of the semiconductor device applications. Rather, the main purpose of this book is to provide an introductory perspective on the basic principles of semiconductor materials and their applications that are described in a relatively concise format in a single volume. Thus, this book should especially be suitable as an introductory text for a single course on semiconductor materials that may be taken by both undergraduate and graduate engineering students. This book should also be useful, as a concise reference on semiconductor materials, for researchers working in a wide variety of fields in physical and engineering sciences.

An informal and highly accessible writing style, a simple treatment of mathematics, and clear guide to applications, have made this book a classic text in electrical and electronic engineering. Students will find it both readable and comprehensive. The fundamental ideas relevant to the understanding of the electrical properties of materials are emphasized; in addition, topics are selected in order to explain the operation of devices having applications (or possible future applications) in engineering. The mathematics, kept deliberately to a minimum, is well within the grasp of a second-year student. This is achieved by choosing the simplest model that can display the essential properties of a phenomenom, and then examining the difference between the ideal and the actual behaviour. The whole text is designed as an undergraduate course. However most individual sections are self contained and can be used as background reading in graduate courses,

and for interested persons who want to explore advances in microelectronics, lasers, nanotechnology and several other topics that impinge on modern life.

Praise for the First Edition "The book goes beyond the usual textbook in that it provides more specific examples of real-world defect physics ... an easy reading, broad introductory overview of the field" ?Materials Today "... well written, with clear, lucid explanations ..." ?Chemistry World This revised edition provides the most complete, up-to-date coverage of the fundamental knowledge of semiconductors, including a new chapter that expands on the latest technology and applications of semiconductors. In addition to inclusion of additional chapter problems and worked examples, it provides more detail on solid-state lighting (LEDs and laser diodes). The authors have achieved a unified overview of dopants and defects, offering a solid foundation for experimental methods and the theory of defects in semiconductors. Matthew D. McCluskey is a professor in the Department of Physics and Astronomy and Materials Science Program at Washington State University (WSU), Pullman, Washington. He received a Physics Ph.D. from the University of California (UC), Berkeley. Eugene E. Haller is a professor emeritus at the University of California, Berkeley, and a member of the National Academy of Engineering. He received a Ph.D. in Solid State and Applied Physics from the University of Basel, Switzerland.

Fungi: Biology and Applications is a comprehensive, balanced introduction of the biology, biotechnological applications and medical significance of fungi. With no prior knowledge of the subject assumed, the opening chapters offer a broad overview of the basics of fungal biology, in particular the physiology and genetics of fungi. Later chapters move on to include more detailed coverage of topics such as proteomics, bioinformatics, heterologous protein expression, medical mycology, anti-fungal drug development and function, fungal biotechnology and fungal pathogens of economically important plants. Carefully structured, each chapter contains self-assessment exercises with answers included at the end of the book to enhance student understanding. * A comprehensive treatment of the medical and economic importance of fungi to everyday life * Chapters include revision sections and problems to reinforce key concepts * Invaluable for undergraduates taking a first course on fungal biology or mycology. * also of interest to those working within the field looking for an up-to-date introduction.

This text brings together traditional solid-state approaches from the 20th century with developments of the early part of the 21st century, to reach an understanding of semiconductor physics in its multifaceted forms. It reveals how an understanding of what happens within the material can lead to insights into what happens in its use.

Modern Semiconductor Quantum Physics has the following constituents: (1) energy band theory: pseudopotential method (empirical and ab initio); density functional theory; quasi-particles; LCAO method; k.p method; spin-orbit splitting; effect mass and Luttinger parameters; strain effects and deformation potentials; temperature effects. (2) Optical properties: absorption and exciton effect; modulation spectroscopy; photo luminescence and photo luminescence excitation; Raman scattering and polaritons; photoionization. (3) Defects and Impurities: effective mass theory and shallow impurity states; deep state cluster method, super cell method, Green's function method; carrier recombination kinetics; trapping transient measurements; electron spin resonance; electron lattice interaction and lattice relaxation effects; multi-phonon nonradiative recombination; negative U center, DX center and EL2 Defects. (4) Semiconductor surfaces: two dimensional periodicity and surface reconstruction; surface electronic states; photo-electron spectroscopy; LEED, STM and other experimental methods. (5) Low-dimensional structures: Heterojunctions,

quantum wells; superlattices, quantum-confined Stark effect and Wannier-Stark ladder effects; resonant tunneling, quantum Hall effect, quantum wires and quantum dots.This book can be used as an advanced textbook on semiconductor physics for graduate students in physics and electrical engineering departments. It is also useful as a research reference for solid state scientists and semiconductor device engineers.

Introduces the study of the physical properties of solids, providing a theoretical framework for understanding the electrical, dielectric, magnetic, elastic, and thermal properties of solids in terms of basic physical laws.

Provides a multidisciplinary introduction to quantum mechanics, solid state physics, advanced devices, and fabrication Covers wide range of topics in the same style and in the same notation Most up to date developments in semiconductor physics and nano-engineering Mathematical derivations are carried through in detail with emphasis on clarity Timely application areas such as biophotonics , bioelectronics

Shows how the design process can be successfully applied to satisfy market needs and trends Fashion design seems to be a glamorous mystery for which only the fortunate few have sufficient talent to succeed. In reality, commercially successful results can be achieved if the right processes are followed in the early design process. Fashion Design sets out basic principles and exercises in order to make fashion design a logical process, providing a framework from which they can expand your skills steadily. Fashion Design, 2nd Edition: Shows how the design process can be successfully applied to satisfy market needs and trends Has a problem solving approach, with practical design projects and portfolio exercises to encourage readers to develop their innovation, experimentation and versatility Pays special attention to computer-aided design (CAD) and employment opportunities, including an overview of what is involved in studying and becoming a designer in the contemporary fashion industry.

This monograph is written for neophytes, students, and practitioners to aid in their understanding of single event phenomena. It attempts to collect the highlights as well as many of the more detailed aspects of this field into an entity that portrays the theoretical as well as the practical applications of this subject. Those who claim that "theory" is not for them can skip over the earlier chapters dealing with the fundamental and theoretical portions and find what they need in the way of hands-on guidelines and pertinent formulas in the later chapters. Perhaps, after a time they will return to peruse the earlier chapters for a more complete rendition and appreciation of the subject matter. It is felt that the reader should have some acquaintance with the electronics of semiconductors and devices, some broad atomic physics introduction, as well as a respectable level of mathematics through calculus, including simple differential equations. A large part of the preceding can be obtained informally, through job experience, self-study, evening classes, as well as from a formal college curriculum.

This review volume consists of scientific articles representing the frontier and most advanced progress in the field of semiconductor physics and lattice dynamics. Contents:Modern Physics and Warm Friendship (C N Yang)Semiconductor Surfaces and Interfaces Studied with Synchrotron Radiation (R Bachrach et al.)A Perspective of the Development of Semiconductor Superlattices and Quantum Wells (L L Chang)Laser Studies of Polaritrons (Y R Shen)Magnetooptics of 2D-Electrons in Regime of

Quantum Hall Effect (V B Timofeev)Quantal Versus Classical Pictures for the Optically Excited Electron Interacting with Phonons (Y Toyozawa)Phonoriton: A New Elementary Excitation in Semiconductors under Intense Pump Conditions (J L Birman & B S Wang)Realistic Calculation on the Second Order Nonlinear Susceptibility Tensor in Cubic Semiconductors (W Y Ching & S S Wang)Molecular Dynamics and Quantum Monte Carlo Simulations of Static and Dynamical Properties of Bulk and Surface Phonons (A A Maradudin et al.)Point Defects and Recombination in Semiconductors (J M Langer)Optical Transitions in Very Short Period GaAs-AlAs Superlattices (M D Sturge et al.)Two-Dimensional Electron Gas in Amorphous-Crystalline Si Heterojunction (R Q Han & X Y Liu)Hydrogen in Crystalline Silicon and Gallium Arsenic (G G Qin)Interaction Effects and Influence on Magnetoresistances in Two-Dimensional Hole Systems (H Z Zheng)Lattice and Spin Relaxation Approach in Low-Dimensional Physics (Z B Su & L Yu)and other papers Readership: Physicists and condensed matter physicists. Keywords:Lattice Dynamics;Semiconductor Physics;Synchrotron Radiation

Physics of Semiconductor Devices covers both basic classic topics such as energy band theory and the gradual-channel model of the MOSFET as well as advanced concepts and devices such as MOSFET short-channel effects, low-dimensional devices and single-electron transistors. Concepts are introduced to the reader in a simple way, often using comparisons to everyday-life experiences such as simple fluid mechanics. They are then explained in depth and mathematical developments are fully described. Physics of Semiconductor Devices contains a list of problems that can be used as homework assignments or can be solved in class to exemplify the theory. Many of these problems make use of Matlab and are aimed at illustrating theoretical concepts in a graphical manner.

Heterostructure Lasers, Part A: Fundamental Principles deals with the fundamental principles, preparation, and operating characteristics of heterostructure lasers. Each major topic is introduced along with the basic laws that govern the observed phenomena. The expressions relevant to heterostructure lasers are derived from the basic laws, and realistic numerical examples based on the GaAs-AlxGa1-xAs heterostructure are given. This book is comprised of four chapters and begins with a discussion on some of the early studies of injection lasers and an overview of the fundamental concepts of heterostructure lasers. Stimulated emission and room temperature continuous-wave operation with injection lasers are described, together with the fundamentals of waveguiding, gain, and carrier confinement in heterostructures. Optical fields and wave propagation are considered, along with slab-electric waveguides; the relationships between absorption, stimulated emission, and spontaneous emission; optical absorption and emission rates in semiconductors; and electrical properties of heterojunctions. This monograph will be of interest to physicists.

While the standard solid state topics are covered, the basic ones often have more detailed derivations than is customary (with an empasis on crystalline solids). Several recent topics are introduced, as are some subjects normally included only in condensed matter physics. Lattice vibrations, electrons, interactions, and spin effects (mostly in magnetism) are discussed the most comprehensively. Many problems are included whose level is from "fill in the steps" to long and challenging, and the text is equipped with references and several comments about experiments with figures and tables.

This book is a comprehensive text on the physics of semiconductors and nanostructures for a large spectrum of students at the final

undergraduate level studying physics, material science and electronics engineering. It offers introductory and advanced courses on solid state and semiconductor physics on one hand and the physics of low dimensional semiconductor structures on the other in a single text book. Key Features Presents basic concepts of quantum theory, solid state physics, semiconductors, and quantum nanostructures such as quantum well, quantum wire, quantum dot and superlattice In depth description of semiconductor heterojunctions, lattice strain and modulation doping technique Covers transport in nanostructures under an electric and magnetic field with the topics: quantized conductance, Coulomb blockade, and integer and fractional quantum Hall effect Presents the optical processes in nanostructures under a magnetic field Includes illustrative problems with hints for solutions in each chapter Physics of Semiconductors and Nanostructures will be helpful to students initiating PhD work in the field of semiconductor nanostructures and devices. It follows a unique tutorial approach meeting the requirements of students who find learning the concepts difficult and want to study from a physical perspective.

Dopants and Defects in Semiconductors covers the theory, experimentation, and identification of impurities, dopants, and intrinsic defects in semiconductors. The book fills a crucial gap between solid-state physics and more specialized course texts. The authors first present introductory concepts, including basic semiconductor theory, defect classifications, crystal growth, and doping. They then explain electrical, vibrational, optical, and thermal properties. Moving on to characterization approaches, the text concludes with chapters on the measurement of electrical properties, optical spectroscopy, particle-beam methods, and microscopy. By treating dopants and defects in semiconductors as a unified subject, this book helps define the field and prepares students for work in technologically important areas. It provides students with a solid foundation in both experimental methods and the theory of defects in semiconductors.

Everyone in the fashion business needs to develop an essential survival skill: how to interpret the intelligence provided by the fashion forecasting industry, to anticipate and respond to emerging trends. Lavishly illustrated in full colour throughout, with clear and relevant explanations of the processes involved, Fashion Forecasting is for fashion students and young professionals who already have acquired some fashion knowledge and skills. The authors interviewed the key players within this exciting industry and provide here fascinating insights into the dynamic contemporary fashion forecasting world and the varied creative roles within it - from intelligence gatherers to project consultants. The book covers how a trend is sourced, anticipated and developed, and also explores the interaction with marketing and brand development.

Lectures on Solid State Physics is a compilation of lectures concerned with various branches of solid state physics. It aims to develop basic physical ideas that lead to a better understanding of phenomena and effects. Comprised of 11 chapters, this book discusses several topics on solid state physics: structure of solids; interference effects in crystals; lattice dynamics; perfect and imperfect crystals; electrons and electron theory of metals; semiconductors; electrical contact effects; transport phenomena, and magnetism. Students, physics graduates, electrical engineers, chemists, and metallurgists will find this book invaluable.

To push MOSFETs to their scaling limits and to explore devices that may complement or even replace them at molecular scale, a clear understanding of device physics at nanometer scale is necessary. Nanoscale Transistors provides a description on the recent development of theory, modeling, and simulation of nanotransistors for electrical engineers, physicists, and chemists working on nanoscale devices. Simple physical pictures and semi-analytical models, which were validated by detailed numerical simulations, are provided for both evolutionary and revolutionary nanotransistors. After basic concepts are reviewed, the text summarizes the essentials of traditional semiconductor devices, digital circuits, and systems to supply a baseline against which new devices can be assessed. A nontraditional view of the MOSFET using

concepts that are valid at nanoscale is developed and then applied to nanotube FET as an example of how to extend the concepts to revolutionary nanotransistors. This practical guide then explore the limits of devices by discussing conduction in single molecules

The aim of this book is a discussion, at the introductory level, of some applications of solid state physics. The book evolved from notes written for a course offered three times in the Department of Physics of the University of California at Berkeley. The objects of the course were (a) to broaden the knowledge of graduate students in physics, especially those in solid state physics; (b) to provide a useful course covering the physics of a variety of solid state devices for students in several areas of physics; (c) to indicate some areas of research in applied solid state physics. To achieve these ends, this book is designed to be a survey of the physics of a number of solid state devices. As the italics indicate, the key words in this description are physics and survey. Physics is a key word because the book stresses the basic qualitative physics of the applications, in enough depth to explain the essentials of how a device works but not deeply enough to allow the reader to design one. The question emphasized is how the solid state physics of the application results in the basic useful property of the device. An example is how the physics of the tunnel diode results in a negative dynamic resistance. Specific circuit applications of devices are mentioned, but not emphasized, since expositions are available in the elec trical engineering textbooks given as references.

For some time there has been a need for a semiconductor device book that carries diode and transistor theory beyond an introductory level and yet has space to touch on a wider range of semiconductor device principles and applica tions. Such topics are covered in specialized monographs numbering many hun dreds, but the voluminous nature of this literature limits access for students. This book is the outcome of attempts to develop a broad course on devices and integrated electronics for university students at about senior-year level. The edu cational prerequisites are an introductory course in semiconductor junction and transistor concepts, and a course on analog and digital circuits that has intro duced the concepts of rectification, amplification, oscillators, modulation and logic and SWitching circuits. The book should also be of value to professional engineers and physicists because of both, the information included and the de tailed guide to the literature given by the references. The aim has been to bring some measure of order into the subject area examined and to provide a basic structure from which teachers may develop themes that are of most interest to students and themselves. Semiconductor devices and integrated circuits are reviewed and fundamental factors that control power levels, frequency, speed, size and cost are discussed. The text also briefly mentions how devices are used and presents circuits and comments on representative applications. Thus, the book seeks a balance be tween the extremes of device physics and circuit design.

Graduate text with comprehensive treatment of semiconductor device physics and engineering, and descriptions of real

optoelectronic devices.
Updated to reflect recent work in the field, this book emphasizes crystalline solids, going from the crystal lattice to the ideas of reciprocal space and Brillouin zones, and develops these ideas for lattice vibrations, for the theory of metals, and for semiconductors. The theme of lattice periodicity and its varied consequences runs through eighty percent of the book. Other sections deal with major aspects of solid state physics controlled by other phenomena: superconductivity, dielectric and magnetic properties, and magnetic resonance.
This book has been designed primarily as a text book for a three-semester, three· hour per week senior or graduate course in semiconductor physics for students In electrical engineering and physics, It may be supplemented by a solid state phy .. ics course. Prerequisites are courses in electrodynamics and -for some of the chapters -basic quantum mechanics. Emphasis has been laid on physical rather than technological aspects. Semiconductor physics is in fact an excellent and d ... · manding training ground for a future physicist or electrical engineer givina him an opportunity to practice a large variety of physical laws he was introduced to in the more fundamental courses. A detailed treatment of the transport and optical properties of semiconducton is given. It was decided to omit the usual description of the material propertkl of certain semiconductors and instead to include the "in· between" equations In mathematical derivations which I hope will make life simpler for a non·theorell· ciano In view of the many thousands of papers which appear every y ... ar in th ... field of semiconductor physics and which are distributed amona more than 30 journals, it would have been impossible for a single person to writ ... comprehen· sive book unless there had not been some excellent review art ides on speCial top ics published in the series "Solid State Physics", "FestkOrper·Probleme! Ad· vances in Solid State Physics", "Semiconductors and Semimetals". and "Proareu in Semiconductors", and I have leaned heavily on such review articles.
These proceedings cover the lectures delivered at the Fourth International Summer College on Physics and Contemporary Needs held from June 16 - July 4, 1979 at Nathiagali, one of the scenic hill resorts in the northern part of Pakistan. The college was organised by Pakistan Atomic Energy Commission (PAEC) and co-sponsored by the International Centre for Theoretical Physics, Trieste (ICTP), Italy. It also received a financial grant from the University Grants Commi ssion for the participation of physicists from various universities of Pakistan. The college was attended by 16 lecturers and invited seminar speakers. It was attended by 186 participants from 28 coun tries and consisted of 15 concentrated days of lectures, seminars and informal discussions. These proceedings contain only regular lectures delivered at Nathiagali but the seminars held there are listed in the Appendix. This year the college put special emphasis on various energy systems, including their long term implications, and computer software. However, the lectures

delivered at the college also covered a wide spectrum of physics. The series of the colleges of which the present college is the fourth one are an attempt to remove the barrier of isolation for the physicists working in developing coun tries, far removed from active centres of research. Thus these colleges could help to fill the important gap in communication between the physicists of developing and advanced countries.

The purpose of this book is to provide the reader with a self-contained treatment of fundamen tal solid state and semiconductor device physics. The material presented in the text is based upon the lecture notes of a one-year graduate course sequence taught by this author for many years in the ·Department of Electrical Engineering of the University of Florida. It is intended as an introductory textbook for graduate students in electrical engineering. However, many students from other disciplines and backgrounds such as chemical engineering, materials science, and physics have also taken this course sequence, and will be interested in the material presented herein. This book may also serve as a general reference for device engineers in the semiconductor industry. The present volume covers a wide variety of topics on basic solid state physics and physical principles of various semiconductor devices. The main subjects covered include crystal structures, lattice dynamics, semiconductor statistics, energy band theory, excess carrier phenomena and recombination mechanisms, carrier transport and scattering mechanisms, optical properties, photoelectric effects, metal-semiconductor devices, the p--n junction diode, bipolar junction transistor, MOS devices, photonic devices, quantum effect devices, and high speed III-V semiconductor devices. The text presents a unified and balanced treatment of the physics of semiconductor materials and devices. It is intended to provide physicists and mat erials scientists with more device backgrounds, and device engineers with a broader knowledge of fundamental solid state physics.

The ideal companion in condensed matter physics - now in new and revised edition. Solving homework problems is the single most effective way for students to familiarize themselves with the language and details of solid state physics. Testing problem-solving ability is the best means at the professor's disposal for measuring student progress at critical points in the learning process. This book enables any instructor to supplement end-of-chapter textbook assignments with a large number of challenging and engaging practice problems and discover a host of new ideas for creating exam questions. Designed to be used in tandem with any of the excellent textbooks on this subject, Solid State Physics: Problems and Solutions provides a self-study approach through which advanced undergraduate and first-year graduate students can develop and test their skills while acclimating themselves to the demands of the discipline. Each problem has been chosen for its ability to illustrate key concepts, properties, and systems, knowledge of which is crucial in developing a complete understanding of the subject, including: * Crystals, diffraction, and reciprocal lattices. * Phonon dispersion and electronic band structure. * Density of states. * Transport, magnetic, and optical properties. * Interacting electron systems. * Magnetism. * Nanoscale Physics.

Solid State Physics: An Introduction to Theory presents an intermediate quantum approach to the properties of solids. Through this lens, the text explores different properties, such as lattice, electronic, elastic, thermal, dielectric, magnetic, semiconducting, superconducting and optical and transport properties, along with the structure of crystalline solids. The work presents the general theory for most of the properties

of crystalline solids, along with the results for one-, two- and three-dimensional solids in particular cases. It also includes a brief description of emerging topics, such as the quantum hall effect and high superconductivity. Building from fundamental principles and requiring only a minimal mathematical background, the book includes illustrative images and solved problems in all chapters to support student understanding. Provides an introduction to recent topics, such as the quantum hall effect, high-superconductivity and nanomaterials Utilizes the Dirac' notation to highlight the physics contained in the mathematics in an appropriate and succinct manner Includes many figures and solved problems throughout all chapters to provide a deeper understanding for students Offers topics of particular interest to engineering students, such as elasticity in solids, dislocations, polymers, point defects and nanomaterials

This book provides one of the most rigorous treatments of compound semiconductor device physics yet published. A complete understanding of modern devices requires a working knowledge of low-dimensional physics, the use of statistical methods, and the use of one-, two-, and three-dimensional analytical and numerical analysis techniques. With its systematic and detailed**discussion of these topics, this book is ideal for both the researcher and the student. Although the emphasis of this text is on compound semiconductor devices, many of the principles discussed will also be useful to those interested in silicon devices. Each chapter ends with exercises that have been designed to reinforce concepts, to complement arguments or derivations, and to emphasize the nature of approximations by critically evaluating realistic conditions. One of the most rigorous treatments of compound semiconductor device physics yet published**Essential reading for a complete understanding of modern devices**Includes chapter-ending exercises to facilitate understanding

Semiconductor Physics and Devices provides an introduction to the physics of semiconductor materials and devices. The text is supported by a large number of examples and exercises to test the understanding of topics.

Discovery of new transport phenomena and invention of electron devices through exploitation of these phenomena have caused a great deal of interest in the properties of compound semiconductors in recent years. Extensive re search has been devoted to the accumulation of experimental results, par ticularly about the artificially synthesised compounds. Significant ad vances have also been made in the improvement of the related theory so that the values of the various transport coefficients may be calculated with suf ficient accuracy by taking into account all the complexities of energy band structure and electron scattering mechanisms. Knowledge about these deve lopments may, however, be gathered only from original research contributions, scattered in scientific journals and conference proceedings. Review articles have been published from time to time, but they deal with one particular material or a particular phenomenon and are written at an advanced level. Available text books on semiconductor physics, do not cover the subject in any detail since many of them were written decades ago. There is, there fore, a definite need for a book, giving a comprehensive account of electron transport in compound semiconductors and covering the introductory material as well as the current work. The present book is an attempt to fill this gap in the literature. The first chapter briefly reviews the history of the developement of compound semiconductors and their applications. It is also an introduction to the contents of the book.