

Geometrical Optics And Optical Design

A practical guide for engineers and students that covers a wide range of optical design and optical metrology topics Optical Engineering Science offers a comprehensive and authoritative review of the science of optical engineering. The book bridges the gap between the basic theoretical principles of classical optics and the practical application of optics in the commercial world. Written by a noted expert in the field, the book examines a range of practical topics that are related to optical design, optical metrology and manufacturing. The book fills a void in the literature by covering all three topics in a single volume. Optical engineering science is at the foundation of the design of commercial optical systems, such as mobile phone cameras and digital cameras as well as highly sophisticated instruments for commercial and research applications. It spans the design, manufacture and testing of space or aerospace instrumentation to the optical sensor technology for environmental monitoring. Optics engineering science has a wide variety of applications, both commercial and research. This important book: Offers a comprehensive review of the topic of optical engineering Covers topics such as optical fibers, waveguides, aspheric surfaces, Zernike polynomials, polarisation, birefringence and more Targets engineering

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professionals and students Filled with illustrative examples and mathematical equations Written for professional practitioners, optical engineers, optical designers, optical systems engineers and students, Optical Engineering Science offers an authoritative guide that covers the broad range of optical design and optical metrology topics and their applications.

Although the subject of optical design as a branch of applied physics is over one hundred years old, the use of aberration theory has changed considerably.

Aberrations of Optical Systems covers elementary optics and aberration theory of various optical systems, including the use of nonaxially symmetric systems and diffractive optical elements in complex designs, such as head-up displays and the increasing use of scanning systems with laser illumination. The book provides the complete range of mathematical tools, formulae, and derivations needed for understanding the process of optical design and for planning optical design programs. While the treatment is mainly based on geometrical optics, some excursions into physical optics are made, particularly in connection with the problems of optical tolerances.

The Art and Science of Optical Design is a comprehensive introduction to lens design, covering the fundamental physical principles and key engineering issues. Several practical examples of modern computer-aided lens design are worked

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out in detail from start to finish. The basic theory and results of optics are presented early on in the book, along with a discussion of optical materials. Aberrations, and their correction, and image analysis are then covered in great detail. Subsequent chapters deal with design optimisation and tolerance analysis. Several design examples are then given, beginning with basic lens design forms, and progressing to advanced systems, such as gradient index and diffractive optical components. In covering all aspects of optical design, including the use of modern lens design software, this book will be invaluable to students of optical engineering as well as to anyone engaged in optical design at any stage. Knowledge of microscope design is rapidly becoming more important. Microscopes are used in critical applications such as drug development, clinical tests, and genomics. Considerable expertise is required for the evaluation, design, and manufacture of these instruments. Several subsystems must be integrated: the source, the illumination optics, the specimen, the objective lens, the tube optics, and the sensor. The large numerical aperture of a microscope is essential for small spot size and high brightness; however, the large numerical aperture also presents difficult issues in optical design and fabrication. This book provides a foundation for developing design expertise through education, practice, and exploration. It is suitable for lens designers, optical engineers, and

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students with a basic knowledge of microscope structure.

This Field Guide derives from the treatment of geometrical optics that has evolved from both the undergraduate and graduate programs at the Optical Sciences Center at the University of Arizona. The development is both rigorous and complete, and it features a consistent notation and sign convention. This volume covers Gaussian imagery, paraxial optics, first-order optical system design, system examples, illumination, chromatic effects, and an introduction to aberrations. The appendices provide supplemental material on radiometry and photometry, the human eye, and several other topics.

This classic resource provides a clear, well-illustrated introduction to the essentials of optical design—from basic principles to cutting-edge design methods. Infused with more than 500 tables and figures, this reference clearly illustrates the intricacies of optical system design and evaluation and considers key aspects of component selection, optimization, and integration for the development of effective optical apparatus. The book provides a much-needed update on the vanguard in the field with vivid e

The process of designing lenses is both an art and a science. While advancements in the field over the past two centuries have done much to transform it from the former category to the latter, much of the lens design process remains encapsulated in the experience and knowledge of industry veterans. This Field Guide provides a working reference for practicing physicists, engineers, and scientists for deciphering the nuances of basic lens design. The

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book begins with an outline of the general process before delving into aberrations, basic lens design forms, and optimization. An entire section is devoted to techniques for improving lens performance. Sections on tolerancing, stray light, and optical systems are followed by an appendix covering related topics such as optical materials, nonimaging concepts, designing for sampled imaging, and ray tracing fundamentals.

A practical introductory guide to optical design covering geometrical optics, simple wave-optics and diffraction, using Excel software • explains practical calculation methods for designing optical systems with fully worked-out examples and avoiding complex mathematical methods • includes practical calculations for ray tracing, laser beam (Gaussian beam) focusing, and diffraction calculations; the ray tracing and the diffraction calculations are done by using the VBA program which Excel provides as a supporting tool • describes basic optical theory and application methods, and provides readers with calculation methods for designing laser optical systems with numerous practical calculation examples. After finishing the book, even inexperienced readers should have the ability to design laser optical systems • covers large areas of geometrical optics and diffraction theory, providing a good overview and reference for beginners or non-specialist engineers • accompanied by a website including password protected electronic files

This book computes the first- and second-order derivative matrices of skew ray and optical path length, while also providing an important mathematical tool for automatic optical design. This book consists of three parts. Part One reviews the basic theories of skew-ray tracing, paraxial optics and primary aberrations – essential reading that lays the foundation for the modeling work presented in the rest of this book. Part Two derives the Jacobian matrices of a

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ray and its optical path length. Although this issue is also addressed in other publications, they generally fail to consider all of the variables of a non-axially symmetrical system. The modeling work thus provides a more robust framework for the analysis and design of non-axially symmetrical systems such as prisms and head-up displays. Lastly, Part Three proposes a computational scheme for deriving the Hessian matrices of a ray and its optical path length, offering an effective means of determining an appropriate search direction when tuning the system variables in the system design process.

A Course in Lens Design is an instruction in the design of image-forming optical systems. It teaches how a satisfactory design can be obtained in a straightforward way. Theory is limited to a minimum, and used to support the practical design work. The book introduces geometrical optics, optical instruments and aberrations. It gives a description of the process of lens design and of the strategies used in this process. Half of its content is devoted to the design of sixteen types of lenses, described in detail from beginning to end. This book is different from most other books on lens design because it stresses the importance of the initial phases of the design process: (paraxial) lay-out and (thin-lens) pre-design. The argument for this change of accent is that in these phases much information can be obtained about the properties of the lens to be designed. This information can be used in later phases of the design. This makes A Course in Lens Design a useful self-study book and a suitable basis for an introductory course in lens design. The mathematics mainly used is college algebra, in a few sections calculus is applied. The book could be used by students of engineering and technical physics and by engineers and scientists.

Handbook of Optical Design, Third Edition covers the fundamental principles of geometric

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optics and their application to lens design in one volume. It incorporates classic aspects of lens design along with important modern methods, tools, and instruments, including contemporary astronomical telescopes, Gaussian beams, and computer lens design. Written by respected researchers, the book has been extensively classroom-tested and developed in their lens design courses. This well-illustrated handbook clearly and concisely explains the intricacies of optical system design and evaluation. It also discusses component selection, optimization, and integration for the development of effective optical apparatus. The authors analyze the performance of a wide range of optical materials, components, and systems, from simple magnifiers to complex lenses used in photography, ophthalmology, telescopes, microscopes, and projection systems. Throughout, the book includes a wealth of design examples, illustrations, and equations, most of which are derived from basic principles. Appendices supply additional background information. What's New in This Edition Improved figures, including 32 now in color Updates throughout, reflecting advances in the field New material on Buchdahl high-order aberrations Expanded and improved coverage of the calculation of wavefront aberrations based on optical path An updated list of optical materials in the appendix A clearer, more detailed description of primary aberrations References to important new publications Optical system design examples updated to include newly available glasses 25 new design examples This comprehensive book combines basic theory and practical details for the design of optical systems. It is an invaluable reference for optical students as well as scientists and engineers working with optical instrumentation.

This text is written for engineers and scientists who have some experience in the

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field of optics and want to know more about the details and derivations of equations used in optical design. Organized by topic, the book begins with the fundamental law of geometrical optics, Snell's law of refraction, and states the paraxial ray trace equations, then moves on to thin lenses and increasingly more sophisticated components and multi-element systems. Each topic is covered in depth and provides comprehensive information on performance and limitations. While the text is based on general optical laws, special emphasis has been placed on the two major infrared regions--the mid-wave (MWIR) and the long-wave (LWIR). This is particularly important with regard to diffractive hybrids, which have found their place in these long-wavelength areas for the correction of chromatic aberrations and athermalization. Comments relating to single-point diamond turning have also been included because this process is predominantly used to produce optical elements for the infrared regions.

Geometrical Optics and Optical Design is an up-to-date introductory treatment of geometrical optics which is intended to lead students toward the modern practices of computer-aided optical design. The principles of Gaussian optics and first-order layout and design are emphasized, based on the tracing of two paraxial rays and the associated optical invariant. The radiometry of lens systems is seen to rest on the same concepts. Third-order aberration theory is developed

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in detail. Complete examples of third-order design are provided, together with software tools that allow students to follow the examples in detail or to develop other examples independently. Several problems at the end of each chapter allow students to practice and extend the concepts taught.

The Optics of Rays, Wavefronts, and Caustics presents the fundamental principles of geometrical optics and its unique role in modern technology. It also discusses the procedures used in optical design, which are based on geometrical optics. Organized into 16 chapters, this volume begins with an overview of the underlying general mathematical facts, which constitute the substance of geometrical optics. It then presents the various techniques used to solve the ray and wavefront problems in general inhomogeneous medium. Other chapters consider the concept of ray tracing as a tool for calculating the principal curvatures of a wavefront as it propagates through a lens. In addition, the book tackles several topics, including the aspects of lens design, as well as a system of equations that are similar to the Maxwell equations. The last chapter deals with orthotomic systems of rays. Optical designers, optical physicists, theoretical physicists, and mathematicians will find the information and methods in this book extremely useful.

Diffractive optics involves the manipulation of light using diffractive optical

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elements (DOEs). DOEs are being widely applied in such areas as telecommunications, electronics, laser technologies and biomedical engineering. Computer design of diffractive optics provides an authoritative guide to the principles and applications of computer-designed diffractive optics. The theoretical aspects underpinning diffractive optics are initially explored, including the main equations in diffraction theory and diffractive optical transformations. Application of electromagnetic field theory for calculating diffractive gratings and related methods in micro-optics are discussed, as is analysis of transverse modes of laser radiation and the formation of self-replicating multimode laser beams. Key applications of DOEs reviewed include geometrical optics approximation, scalar approximation and optical manipulation of micro objects, with additional consideration of multi-order DOEs and synthesis of DOEs on polycrystalline diamond films. With its distinguished editor and respected team of expert contributors, Computer design of diffractive optics is a comprehensive reference tool for professionals and academics working in the field of optical engineering and photonics. Explores the theoretical aspects underpinning diffractive optics Discusses key applications of diffractive optical elements A comprehensive reference for professionals and academics in optical engineering and photonics

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Basic Optics: Principles and Concepts addresses in great detail the basic principles of the science of optics, and their related concepts. The book provides a lucid and coherent presentation of an extensive range of concepts from the field of optics, which is of central relevance to several broad areas of science, including physics, chemistry, and biology. With its extensive range of discourse, the book's content arms scientists and students with knowledge of the essential concepts of classical and modern optics. It can be used as a reference book and also as a supplementary text by students at college and university levels and will, at the same time, be of considerable use to researchers and teachers. The book is composed of nine chapters and includes a great deal of material not covered in many of the more well-known textbooks on the subject. The science of optics has undergone major changes in the last fifty years because of developments in the areas of the optics of metamaterials, Fourier optics, statistical optics, quantum optics, and nonlinear optics, all of which find their place in this book, with a clear presentation of their basic principles. Even the more traditional areas of ray optics and wave optics are elaborated within the framework of electromagnetic theory, at a level more fundamental than what one finds in many of the currently available textbooks. Thus, the eikonal approximation leading to ray optics, the Lagrangian and Hamiltonian formulations of ray optics, the quantum theoretic

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interpretation of interference, the vector and dyadic diffraction theories, the geometrical theory of diffraction, and similar other topics of basic relevance are presented in clear terms. The presentation is lucid and elegant, capturing the essential magic and charm of physics. All this taken together makes the book a unique text, of major contemporary relevance, in the field of optics. Avijit Lahiri is a well-known researcher, teacher, and author, with publications in several areas of physics, and with a broad range of current interests, including physics and the philosophy of science. Provides extensive and thoroughly exhaustive coverage of classical and modern optics Offers a lucid presentation in understandable language, rendering the abstract and difficult concepts of physics in an easy, accessible way Develops all concepts from elementary levels to advanced stages Includes a sequential description of all needed mathematical tools Relates fundamental concepts to areas of current research interest

A concise, yet deep introduction to geometrical optics, developing the practical skills and research techniques routinely used in modern laboratories. Suitable for both students and self-learners, this accessible text teaches readers how to build their own optical laboratory, and design and perform optical experiments.

Discussing the principles of physical and geometrical optics from an engineering point of view, this book explains current optical technology and the applications of optical methods in a wide

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variety of fields, from astronomy and agriculture to medicine and semiconductors. It offers guidance in the selection of optical components for the construction of bread-board models using commercially available, standard components, and provides immediately useful equations without unnecessary mathematical derivations.

This book gives a detailed description of lens behaviour in real optical systems.

This book—unique in the literature—provides readers with the mathematical background needed to design many of the optical combinations that are used in astronomical telescopes and cameras. The results presented in the work were obtained by using a different approach to third-order aberration theory as well as the extensive use of the software package Mathematica®. Replete with workout examples and exercises, Geometric Optics is an excellent reference for advanced graduate students, researchers, and practitioners in applied mathematics, engineering, astronomy, and astronomical optics. The work may be used as a supplementary textbook for graduate-level courses in astronomical optics, optical design, optical engineering, programming with Mathematica, or geometric optics.

Optical imaging starts with geometrical optics, and ray tracing lies at its forefront. This book starts with Fermat's principle and derives the three laws of geometrical optics from it. After discussing imaging by refracting and reflecting systems, paraxial ray tracing is used to determine the size of imaging elements and obscuration in mirror systems. Stops, pupils, radiometry, and optical instruments are also discussed. The chromatic and monochromatic aberrations are addressed in detail, followed by spot sizes and spot diagrams of aberrated images of point objects. Each chapter ends with a summary and a set of problems. The book ends with an epilogue that summarizes the imaging process and outlines the next steps within

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and beyond geometrical optics.

Classic detailed treatment for practical designer. Fundamental concepts, systematic study and design of all types of optical systems. Reader can then design simpler optical systems without aid. Part Two of Two.

A concise introduction to lens design, including the fundamental theory, concepts, methods and tools used in the field. Covering all the essential concepts and providing suggestions for further reading at the end of each chapter, this book is an essential resource for graduate students working in optics and photonics.

This book provides a clear, concise, and consistent exposition of what aberrations are, how they arise in optical imaging systems, and how they affect the quality of images formed by them. The emphasis of the book is on physical insight, problem solving, and numerical results, and the text is intended for engineers and scientists who have a need and a desire for a deeper and better understanding of aberrations and their role in optical imaging and wave propagation. Some knowledge of Gaussian optics and an appreciation for aberrations would be useful but is not required.

Optical System Design covers the basic knowledge of optics and the flow of light through an optical system. This book is organized into 16 chapters that deal with various components of an optical system, from light and images to spectroscopic apparatus. The book first discusses the simple components of an optical system, including its light, lens, oblique beams, and photochemical aspects. It then deals with the system's projection, plane mirrors, prisms, magnifying instruments, and telescope. Other components considered are the surveying instruments, mirror imaging systems, photographic optics, and spectroscopic apparatus. This

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book is of value to undergraduate students with courses in geometrical optics and system design.

An ideal textbook for advanced undergraduate courses in geometrical optics; includes worked examples and exercises.

This book provides all the essential and best elements of Kidger's many courses taught worldwide on lens and optical design. It is written in a direct style that is compact, logical, and to the point--a tutorial in the best sense of the word. "I read my copy late last year and read it straight through, cover to cover. In fact, I read it no less than three times. Its elegant expositions, valuable insights, and up-front espousal of pre-design theory make it an outstanding work. It's in the same league with Conrady and Kingslake." Warren Smith.

From basic terms and concepts to advanced optimization techniques--a complete, practical introduction to modern geometrical optics Most books on geometrical optics present only matrix methods. Modern Geometrical Optics, although it covers matrix methods, emphasizes y-nu ray tracing methods, which are used most commonly by optical engineers and are easier to adapt to third-order optics and y-??? diagrams. Moving by logical degrees from fundamental principles to advanced optical analysis and design methods, this book bridges the gap between the optical theory taught in introductory physics texts and advanced books on lens design. Providing the background material needed to understand advanced material, it covers important topics such as field of view, stops, pupils and windows, exact ray tracing, image quality, and optimization of the image. Important features of Modern Geometrical Optics include: * Examples of all important techniques presented * Extensive problem sets in each chapter * Optical analysis and design software * Chapters covering y-??? diagrams,

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optimization, and lens design This book is both a primer for professionals called upon to design optical systems and an ideal text for courses in modern geometrical optics. Companion Software Special lens design and analysis software capable of solving all problems presented in the book is available via Wiley's FTP site. This software also serves as an introduction to the use of commercial lens design software. Appendix C is a user's manual for the software. This book employs homogeneous coordinate notation to compute the first- and second-order derivative matrices of various optical quantities. It will be one of the important mathematical tools for automatic optical design. The traditional geometrical optics is based on raytracing only. It is very difficult, if possible, to compute the first- and second-order derivatives of a ray and optical path length with respect to system variables, since they are recursive functions. Consequently, current commercial software packages use a finite difference approximation methodology to estimate these derivatives for use in optical design and analysis. Furthermore, previous publications of geometrical optics use vector notation, which is comparatively awkward for computations for non-axially symmetrical systems.

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