Modern Information Optics with MATLAB

Modern Information Optics with MATLAB is an easy-to-understand course book and is based on the authentic lectures and detailed research, conducted by the authors themselves, on information optics, holography, and MATLAB. This book is the first to highlight the incoherent optical system, provide up-to-date, novel digital holography techniques, and demonstrate MATLAB codes to accomplish tasks such as optical image processing and pattern recognition. This title is a comprehensive introduction to the basics of Fourier optics as well as optical image processing and digital holography. This is a step-by-step guide that details the vast majority of the derivations, without omitting essential steps, to facilitate a clear mathematical understanding. This book also features exercises at the end of each chapter, providing hands-on experience and consolidating the understanding. This book is an ideal companion for graduates and researchers involved in engineering and applied physics, as well as those interested in the growing field of information optics.

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Modern Information Optics with MATLAB

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To my parents, my husband, and my daughter

Yaping Zhang

To my grandchildren, Gussie, Sofia, Camden, and Aiden

Ting-Chung Poon

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Preface

This book covers the basic principles used in information optics including some of its modern topics such as incoherent image processing, incoherent digital holography, modern approaches to computer-generated holography, and devices for optical information processing in information optics. These modern topics continue to find a niche in information optics.

This book will be useful for engineering or applied physics students, scientists, and engineers working in the field of information optics. The writing style of the book is geared toward juniors, seniors, and first-year graduate-level students in engineering and applied physics. We include details on most of the derivations without omitting essential steps to facilitate a clear mathematical development as we hope to build a strong mathematical foundation for undergraduate students. We also include exercises, challenging enough for graduate students, at the end of each chapter.

In the first three chapters of the book, we provide a background on basic optics including ray optics, wave optics, and important mathematical preliminaries for information optics. The book then extensively covers topics of incoherent image processing systems (Chapter 4), digital holography (Chapter 5), including important modern development on incoherent digital holography, and computer-generated holography (Chapter 6). In addition, the book covers in-depth principles of optical devices such as acousto-optic and electro-optic modulators for optical information processing (Chapter 7).

The material covered is enough for a one-semester course (Chapters 1–5) with course titles such as Fourier optics, holography, and modern information optics or a two-course sequence with the second course covering topics from Chapters 6 to 7 (with a brief review of Chapters 3 through 5). Example of a course title would be optical information processing. An important and special feature of this book is to provide the reader with experience in modeling the theory and applications using a commonly used software tool MATLAB®. The use of MATLAB allows the reader to visualize some of the important optical effects such as diffraction, optical image processing, and holographic reconstructions.

Our vision of the book is that there is an English and Chinese version of this book that are printed together as a single textbook. It is the first of its kind in textbooks and a pioneering project. Information optics is a growing field, and there is an enormous need for pioneering books of this kind. A textbook like this will allow students and scholars to appreciate the much-needed Chinese translation of English technical

terms, and vice versa. The textbook also provides them with professional and technical translation in the area of information optics.

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Yaping Zhang would like to thank her parents, her husband, and her daughter (Xinyi Xu) whose encouragement and support have enabled her to fulfill her dreams. In particular, she wishes to express her appreciation to her collaborator, Professor Poon, for his professional knowledge and language polishing that made the book more readable for users, and resulted in the publication of *Modern Information Optics*. Working with Professor Poon on this project was a great pleasure and resulted in further growth in her professional experience.

Ting-Chung Poon is greatly indebted to his parents, whose moral encouragement and sacrifice have enabled him to fulfill his dreams and further his achievements. They shall be remembered forever.