

Contents

| | |
|--|----|
| Preface..... | v |
| 1. Geometrical Optics | |
| 1.1 Fermat's Principle..... | 2 |
| 1.2 Reflection and Refraction | 3 |
| 1.3 Ray Propagation in an Inhomogeneous Medium: Ray Equation..... | 6 |
| 1.4 Matrix Methods in Paraxial Optics | 16 |
| 1.4.1 The Ray Transfer Matrix | 17 |
| 1.4.2 Illustrative examples..... | 25 |
| 1.4.3 Cardinal points of an optical system..... | 27 |
| 1.5 Reflection Matrix and Optical Resonators..... | 32 |
| 1.6 Ray Optics using MATLAB | 37 |
| 2. Wave Propagation and Wave Optics | |
| 2.1 Maxwell's Equations: A Review | 46 |
| 2.2 Linear Wave Propagation | 50 |
| 2.2.1 Traveling-wave solutions | 50 |
| 2.2.2 Maxwell's equations in phasor domain: Intrinsic impedance, the Poynting vector, and polarization..... | 55 |
| 2.2.3 Electromagnetic waves at a boundary and Fresnel's equations..... | 60 |
| 2.3 Wave Optics..... | 73 |
| 2.3.1 Fourier transform and convolution..... | 74 |
| 2.3.2 Spatial frequency transfer function and spatial impulse response of propagation | 75 |

| | | |
|-------|--|-----|
| 2.3.3 | Examples of Fresnel diffraction | 79 |
| 2.3.4 | Fraunhofer diffraction | 80 |
| 2.3.5 | Fourier transforming property of ideal lenses | 83 |
| 2.3.6 | Resonators and Gaussian beams..... | 86 |
| 2.4 | Gaussian Beam Optics and MATLAB Examples..... | 97 |
| 2.4.1 | q-transformation of Gaussian beams | 99 |
| 2.4.2 | MATLAB example: propagation of a Gaussian beam . | 102 |
| 3. | Beam Propagation in Inhomogeneous Media | |
| 3.1 | Wave Propagation in a Linear Inhomogeneous Medium..... | 111 |
| 3.2 | Optical Propagation in Square-Law Media..... | 112 |
| 3.3 | The Paraxial Wave Equation | 119 |
| 3.4 | The Split-Step Beam Propagation Method | 121 |
| 3.5 | MATLAB Examples Using the Split-Step Beam Propagation Method..... | 124 |
| 3.6 | Beam Propagation in Nonlinear Media: The Kerr Media..... | 134 |
| 3.6.1 | Spatial soliton | 136 |
| 3.6.2 | Self-focusing and self-defocusing | 139 |
| 4. | Acousto-Optics | |
| 4.1 | Qualitative Description and Heuristic Background | 152 |
| 4.2 | The Acousto-optic Effect: General Formalism..... | 158 |
| 4.3 | Raman-Nath Equations | 161 |
| 4.4 | Contemporary Approach..... | 164 |
| 4.5 | Raman-Nath Regime..... | 165 |
| 4.6 | Bragg Regime | 166 |
| 4.7 | Numerical Examples..... | 172 |
| 4.8 | Modern Applications of the Acousto-Optic Effect | 178 |
| 4.8.1 | Intensity modulation of a laser beam..... | 178 |
| 4.8.2 | Light beam deflector and spectrum analyzer..... | 181 |
| 4.8.3 | Demodulation of frequency modulated (FM) signals... | 182 |
| 4.8.4 | Bistable switching | 184 |
| 4.8.5 | Acousto-optic spatial filtering | 188 |
| 4.8.6 | Acousto-optic heterodyning | 196 |

| | |
|--|-----|
| 5. Electro-Optics | |
| 5.1 The Dielectric Tensor | 205 |
| 5.2 Plane-Wave Propagation in Uniaxial Crystals; Birefringence..... | 210 |
| 5.3 Applications of Birefringence: Wave Plates | 217 |
| 5.4 The Index Ellipsoid..... | 219 |
| 5.5 Electro-Optic Effect in Uniaxial Crystals | 223 |
| 5.6 Some Applications of the Electro-Optic Effect equations | 227 |
| 5.6.1 Intensity modulation..... | 227 |
| 5.6.2 Phase modulation..... | 236 |
| Index | 241 |