
CONTENTS

Preface vii

1 Wave Optics 1

- 1.1 Introduction 1
- 1.2 Maxwell's Equations 2
- 1.3 The Wave Equation 4
- 1.4 Optical Systems of Cylindrical Symmetry 11
- 1.5 Boundary Conditions 14
- 1.6 Reflection and Refraction at a Dielectric Interface 16

2 Diffraction Theory 30

- 2.1 Introduction 30
- 2.2 The Kirchhoff-Huygens Diffraction Integral 31
- 2.3 Diffraction by a Slit in an Opaque Screen 42
- 2.4 Diffraction by a Circular Aperture 49
- 2.5 Diffraction Gratings 52
- 2.6 Bragg Diffraction: Perturbation Theory 61
- 2.7 Bragg Diffraction: Coupled Wave Theory 72

3 Geometrical Optics 82

- 3.1 Introduction 82
- 3.2 Derivation of Ray Optics from the Wave Equation 83

- 3.3 Boundary Conditions for Light Rays 87
- 3.4 Fermat's Principle 90
- 3.5 Hamiltonian Formulation of Ray Optics 94
- 3.6 Quantum Theory of Light Rays 100
- 3.7 Liouville's Theorem 112

4 Lenses 125

- 4.1 Introduction 125
- 4.2 Ray Optics of Thin Lenses 126
- 4.3 Wave Optics of Thin Lenses 129
- 4.4 Optical Fourier Transform and Spatial Filtering 138
- 4.5 Gas Lenses 144
- 4.6 Resolution Limit of Image Formation 163

5 Lens Waveguides 174

- 5.1 Introduction 174
- 5.2 Ray Optics of the Perfect Lens Waveguide 175
- 5.3 Laser Resonators 184
- 5.4 Lens Waveguides with Curved Axis 187
- 5.5 Lens Waveguides with Random Lens Displacements 195
- 5.6 Normal Modes of the Lens Waveguide 209
- 5.7 Wave Trajectory in a Confocal Lens Waveguide 219
- 5.8 Beam Breakup in Imperfect Lens Waveguides 223

6 Gaussian Beams 230

- 6.1 Introduction 230
- 6.2 Propagation of Gaussian Beams in Free Space 231
- 6.3 Alternate Derivation of the Gaussian Beams 235
- 6.4 Transformation of Gaussian Beams 239
- 6.5 Mode Matching 250
- 6.6 Laser Cavities 253

7 Light Propagation in Square Law Media 263

- 7.1 Introduction 263
- 7.2 Ray Optics of the Square Law Medium 264
- 7.3 Modes of the Square Law Medium 267
- 7.4 Off-Axis Beams in the Square Law Medium 272
- 7.5 Square Law Media with Loss or Gain 275
- 7.6 Lens Properties of Square Law Media 283

8	Optical Fibers and Dielectric Waveguides	286
8.1	Introduction	286
8.2	Guided Modes of Round Optical Fibers	289
8.3	Guided Modes of the Slab Waveguide	305
8.4	Radiation Modes of the Slab Waveguide	313
8.5	Orthogonality Relations	322
8.6	Useful Approximations	326
9	Dielectric Waveguides with Imperfections	340
9.1	Introduction	340
9.2	Slab Waveguide with Imperfect Boundary	341
9.3	Slab Waveguide with Sinusoidal Wall Perturbations	349
9.4	Random Wall Perturbations	368
9.5	Steps and Tapers of the Slab Waveguide	379
9.6	Bending Losses	398
10	Coupling between Dielectric Waveguides	407
10.1	Introduction	407
10.2	Coupled Wave Equations	409
10.3	Coupled Slab Waveguides	417
10.4	Coupling of HE_n Modes of Round Fibers	421
10.5	Cross Talk	426
	Index	439