

Contents

1 A Brief History 1

- 1.1 Prolegomenon 1
- 1.2 In the Beginning 1
- 1.3 From the Seventeenth Century 2
- 1.4 The Nineteenth Century 4
- 1.5 Twentieth-Century Optics 7

2 Wave Motion 10

- 2.1 One-Dimensional Waves 10
- 2.2 Harmonic Waves 14
- 2.3 Phase and Phase Velocity 18
- 2.4 The Superposition Principle 20
- 2.5 The Complex Representation 22
- 2.6 Phasors and the Addition of Waves 23
- 2.7 Plane Waves 24
- 2.8 The Three-Dimensional Differential Wave Equation 28
- 2.9 Spherical Waves 29
- 2.10 Cylindrical Waves 31
- 2.11 Twisted Light 31
- Problems 33

3 Electromagnetic Theory, Photons, and Light 37

- 3.1 Basic Laws of Electromagnetic Theory 38
- 3.2 Electromagnetic Waves 46
- 3.3 Energy and Momentum 49
- 3.4 Radiation 61
- 3.5 Light in Bulk Matter 68
- 3.6 The Electromagnetic-Photon Spectrum 75
- 3.7 Quantum Field Theory 82
- Problems 84

4 The Propagation of Light 88

- 4.1 Introduction 88
- 4.2 Rayleigh Scattering 88
- 4.3 Reflection 96
- 4.4 Refraction 100

- 4.5 Fermat's Principle 109
- 4.6 The Electromagnetic Approach 113
- 4.7 Total Internal Reflection 125
- 4.8 Optical Properties of Metals 131
- 4.9 Familiar Aspects of the Interaction of Light and Matter 134
- 4.10 The Stokes Treatment of Reflection and Refraction 139
- 4.11 Photons, Waves, and Probability 140
- Problems 143

5 Geometrical Optics 151

- 5.1 Introductory Remarks 151
- 5.2 Lenses 151
- 5.3 Stops 175
- 5.4 Mirrors 180
- 5.5 Prisms 191
- 5.6 Fiberoptics 196
- 5.7 Optical Systems 207
- 5.8 Wavefront Shaping 231
- 5.9 Gravitational Lensing 236
- Problems 238

6 More on Geometrical Optics 247

- 6.1 Thick Lenses and Lens Systems 247
- 6.2 Analytical Ray Tracing 251
- 6.3 Aberrations 258
- 6.4 GRIN Systems 276
- 6.5 Concluding Remarks 278
- Problems 278

7 The Superposition of Waves 282

- 7.1 The Addition of Waves of the Same Frequency 283
- 7.2 The Addition of Waves of Different Frequency 294
- 7.3 Anharmonic Periodic Waves 300
- 7.4 Nonperiodic Waves 310
- Problems 324

8 Polarization 330

- 8.1 The Nature of Polarized Light 330**
- 8.2 Polarizers 338**
- 8.3 Dichroism 339**
- 8.4 Birefringence 343**
- 8.5 Scattering and Polarization 353**
- 8.6 Polarization by Reflection 355**
- 8.7 Retarders 358**
- 8.8 Circular Polarizers 365**
- 8.9 Polarization of Polychromatic Light 366**
- 8.10 Optical Activity 367**
- 8.11 Induced Optical Effects—Optical Modulators 372**
- 8.12 Liquid Crystals 376**
- 8.13 A Mathematical Description of Polarization 379**
- Problems 384

9 Interference 390

- 9.1 General Considerations 390**
- 9.2 Conditions for Interference 394**
- 9.3 Wavefront-Splitting Interferometers 397**
- 9.4 Amplitude-Splitting Interferometers 408**
- 9.5 Types and Localization of Interference Fringes 424**
- 9.6 Multiple-Beam Interference 425**
- 9.7 Applications of Single and Multilayer Films 433**
- 9.8 Applications of Interferometry 438**
- Problems 444

10 Diffraction 449

- 10.1 Preliminary Considerations 449**
- 10.2 Fraunhofer Diffraction 457**
- 10.3 Fresnel Diffraction 497**
- 10.4 Kirchhoff's Scalar Diffraction Theory 524**
- 10.5 Boundary Diffraction Waves 527**
- Problems 528

11 Fourier Optics 534

- 11.1 Introduction 534**
- 11.2 Fourier Transforms 534**
- 11.3 Optical Applications 544**
- Problems 575

12 Basics of Coherence Theory 580

- 12.1 Introduction 580**
- 12.2 Fringes and Coherence 582**
- 12.3 Visibility 586**
- 12.4 The Mutual Coherence Function and the Degree of Coherence 589**
- 12.5 Coherence and Stellar Interferometry 595**
- Problems 601

13 Modern Optics: Lasers and Other Topics 604

- 13.1 Lasers and Laserlight 604**
- 13.2 Imagery—The Spatial Distribution of Optical Information 630**
- 13.3 Holography 644**
- 13.4 Nonlinear Optics 659**
- Problems 664
- Appendix 1 669**
- Appendix 2 672**
- Table 1 673**
- Solutions to Selected Problems 677**
- Bibliography 700**
- Index 704**
- List of Tables 714**