

Contents

	Preface	iii
	Chapter 1 The Propagation of Light	1
1.1	Elementary Optical Phenomena and the Nature of Light	2
1.2	Electrical Constants and the Speed of Light	3
1.3	Plane Harmonic Waves. Phase Velocity	7
1.4	Alternative Ways of Representing Harmonic Waves	12
1.5	Group Velocity	13
1.6	The Doppler Effect	15
		v

	Chapter 2 The Vectorial Nature of Light	21
2.1	General Remarks	22
2.2	Energy Flow. The Poynting Vector	24
2.3	Linear Polarization	25
2.4	Circular and Elliptic Polarization	28
2.5	Matrix Representation of Polarization. The Jones Calculus	33
2.6	Reflection and Refraction at a Plane Boundary	38
2.7	Amplitudes of Reflected and Refracted Waves. Fresnel's Equations	40
2.8	The Brewster Angle	47
2.9	The Evanescent Wave in Total Reflection	48
2.10	Phase Changes in Total Internal Reflection	50
2.11	Reflection Matrix	52
	Chapter 3 Coherence and Interference	57
3.1	The Principle of Linear Superposition	58
3.2	Young's Experiment	59
3.3	The Michelson Interferometer	63
3.4	Theory of Partial Coherence. Visibility of Fringes	66
3.5	Coherence Time and Coherence Length	68
3.6	Spectral Resolution of a Finite Wave Train. Coherence and Line Width	71
3.7	Spatial Coherence	74
3.8	Intensity Interferometry	79
3.9	Fourier Transform Spectroscopy	80
	Chapter 4 Multiple-Beam Interference	85
4.1	Interference with Multiple Beams	86
4.2	The Fabry-Perot Interferometer	90
4.3	Resolution of Fabry-Perot Instruments	94
4.4	Theory of Multilayer Films	96
	Chapter 5 Diffraction	105
5.1	General Description of Diffraction	106
5.2	Fundamental Theory	106
5.3	Fraunhofer and Fresnel Diffraction	112
5.4	Fraunhofer Diffraction Patterns	114
5.5	Fresnel Diffraction Patterns	125
5.6	Applications of the Fourier Transform to Diffraction	135
5.7	Reconstruction of the Wave Front by Diffraction. Holography	144

Chapter 6	Optics of Solids	151
6.1	General Remarks	152
6.2	Macroscopic Fields and Maxwell's Equations	152
6.3	The General Wave Equation	154
6.4	Propagation of Light in Isotropic Dielectrics. Dispersion	155
6.5	Propagation of Light in Conducting Media	160
6.6	Reflection and Refraction at the Boundary of an Absorbing Medium	164
6.7	Propagation of Light in Crystals	169
6.8	Double Refraction at a Boundary	180
6.9	Optical Activity	185
6.10	Faraday Rotation in Solids	189
6.11	Other Magneto-optic and Electro-optic Effects	192
6.12	Nonlinear Optics	195
Chapter 7	Thermal Radiation and Light Quanta	203
7.1	Thermal Radiation	204
7.2	Kirchhoff's Law. Blackbody Radiation	204
7.3	Modes of Electromagnetic Radiation in a Cavity	207
7.4	Classical Theory of Blackbody Radiation. The Rayleigh-Jeans Formula	210
7.5	Quantization of Cavity Radiation	211
7.6	Photon Statistics. Planck's Formula	212
7.7	The Photoelectric Effect and the Detection of Individual Photons	217
7.8	Momentum of a Photon. Light Pressure	218
7.9	Angular Momentum of a Photon	219
7.10	Wavelength of a Material Particle. de Broglie's Hypothesis	220
7.11	Heisenberg's Uncertainty Principle	221
Chapter 8	Optical Spectra	225
8.1	General Remarks	226
8.2	Elementary Theory of Atomic Spectra	227
8.3	Quantum Mechanics	233
8.4	The Schrödinger Equation	236
8.5	Quantum Mechanics of the Hydrogen Atom	237
8.6	Radiative Transitions and Selection Rules	243
8.7	Fine Structure of Spectrum Lines. Electron Spin	249
8.8	Multiplicity in the Spectra of Many-Electron Atoms. Spectroscopic Notation	250

8.9	Molecular Spectra	253
8.10	Atomic-Energy Levels in Solids	260
	Chapter 9 Amplification of Light. Lasers	263
9.1	Introduction	264
9.2	Stimulated Emission and Thermal Radiation	265
9.3	Amplification in a Medium	267
9.4	Methods of Producing a Population Inversion	271
9.5	Laser Oscillation	272
9.6	Optical-Resonator Theory	275
9.7	Gas Lasers	281
9.8	Optically Pumped Solid-State Lasers	283
9.9	Dye Lasers	286
9.10	Semiconductor Diode Lasers	288
9.11	Q-Switching and Mode Locking	288
9.12	The Ring Laser	290
	Chapter 10 Ray Optics	293
10.1	Reflection and Refraction at a Spherical Surface	294
10.2	Lenses	296
10.3	Ray Equations	299
10.4	Ray Matrices and Ray Vectors	300
10.5	Periodic Lens Waveguides and Optical Resonators	302
	Appendix I Relativistic Optics	306
I.1	The Michelson-Morley Experiment	306
I.2	Einstein's Postulates of Special Relativity	309
I.3	Relativistic Effects in Optics	310
I.4	The Experiments of Sagnac and of Michelson and Gale to Detect Rotation	315
	References	317
	Answers to Selected Odd-Numbered Problems	319
	Index	323