

# CONTENTS

<b>Preface</b>	<b>v</b>
<b>1 Introduction</b>	<b>1</b>
1-1 Oscillation and Coherence	2
1-2 Stimulated Emission, Population Inversion, and Gain	5
1-3 The Microwave Maser and the Concept of Negative Temperatures	7
1-4 Laser Predictions	10
1-5 The Ruby and Other Types of Lasers	11
1-6 Applications	16
1-7 Organization of the Book	16
<b>2 Resonant Optical Cavities and Characteristics of Gas Lasers</b>	<b>19</b>
2-1 Spontaneous and Induced Emission in Gases	20
2-2 Gain Relations for Gas Lasers	23
2-3 Resonant Modes in Optical Cavities	27
2-4 Pumping Threshold for Laser Oscillations	40
2-5 Mode Selection	42
2-6 Power Output and Hole Burning	48
2-7 Coherence Properties of Laser Radiation, Classical Approach	51
2-8 Noise Characteristics of Lasers	60
<b>3 Solid-state Lasers, Primarily Optically Pumped Ones</b>	<b>66</b>
3-1 Threshold Pumping Power	68
3-2 Transient Behavior of Pulsed Lasers	86
3-3 Spectral Narrowing	105
3-4 Output Wavelengths and Other Characteristics of Optically Pumped Lasers	123

<b>4</b>	<b>Solid-state Coherent-light Amplifiers, Q-switched and Raman Lasers</b>	<b>132</b>
4-1	Amplifiers	134
4-2	Q-switched Lasers	147
4-3	A Proposed Double-quantum Giant-pulse Laser	164
4-4	Raman Lasers	177
<b>5</b>	<b>Spectroscopy, Electric Conduction, and Population Inversion in Gases</b>	<b>197</b>
5-1	Spectroscopy of Alkali-metal Vapors and Ionized Divalent Metals; Population Inversion in Cesium	200
5-2	Optical Pumping: The Cesium Maser	207
5-3	Spectroscopy of Two-electron Systems; Metastable States	210
5-4	Energy Transfer by Collisions	220
5-5	Excitation by a Gaseous Discharge	229
5-6	Other Approaches to Population Inversion in Gases	244
5-7	Specific Gas-maser Systems	244
<b>6</b>	<b>Spectroscopy of Optically Pumped Solid-state Laser Materials</b>	<b>265</b>
6-1	Emission and Absorption Spectra of the Trivalent Rare Earths	267
6-2	Russell-Saunders Coupling	269
6-3	Selection Rules for Free Ions	273
6-4	Effects of the Crystalline Field	275
6-5	The Basis for the Application of Group Theory to Crystal-field Problems	280
6-6	Reduction of Representations of the Rotation Group into Irreducible Representations of Crystal Point Groups	285
6-7	Selection Rules for Static-lattice Radiative Transitions	292
6-8	Electronic Transitions Involving Vibrational Motion	299
6-9	Line Widths of Static-lattice Transitions	314
6-10	Pumping Bands of Lasers; the $4f^n-15d$ Bands of RE <sup>++</sup> Ions	331
6-11	Vibronic Transitions in $4f \rightarrow 5d$ Spectra; the Dynamic Jahn-Teller Effect	344
6-12	Miscellaneous Spectroscopic Properties of Sm <sup>++</sup> ; Parameters Involved in Laser Operation	349
6-13	Other RE <sup>++</sup> Laser Ions; Dy <sup>++</sup> and Tm <sup>++</sup>	352
6-14	RE <sup>3+</sup> Laser Ions	363
<b>7</b>	<b>The Injection Laser</b>	<b>368</b>
7-1	Threshold and Gain Analysis	370
7-2	Energy Levels in Semiconductors	374
7-3	Density and Occupation of Energy States	379
7-4	Optical Transitions	382

7-5	<i>Electrical and Optical Inhomogeneity in the Junction Region; Confinement of the Electromagnetic Modes</i>	390
7-6	<i>Operating Characteristics of GaAs Laser Oscillators</i>	392
7-7	<i>Dependence of Lasing Threshold and Efficiency on Temperature and Doping Level</i>	399
7-8	<i>Injection-laser Amplifiers</i>	400
7-9	<i>Other Injection-laser Materials and Mechanisms; Magnetic-field and Stress Effects</i>	402
<b>8 Applications 412</b>		
8-1	<i>Novel Laser Properties</i>	415
8-2	<i>Precise or Novel Measuring Techniques</i>	420
8-3	<i>Nonlinear Optics, Modulation, Demodulation, and Mixing of Light Beams</i>	435
8-4	<i>Applications of the Focused Power in Laser Beams</i>	459
8-5	<i>Communications</i>	463
8-6	<i>Optical Radar and Meteorology</i>	470
8-7	<i>Coherent-light Image and Data Processing</i>	471
8-8	<i>Sequential Data Processing</i>	479
<b>Name Index 485</b>		
<b>Subject Index 493</b>		