Contents

	Preface to 1st Edition page	e vii
	Preface to 2nd Edition	viii
1	Introduction	1
2	Stimulated and Spontaneous Emission of Radia-	
	tion	9
	2.1 The Approach from Thermodynamics	9
	2.2 The Approach from Quantum Mechanics	16
3	Amplification, and Factors Affecting the Process	34
	3.1 The Possibility of Amplification	34
	3.2 Factors Affecting the Amplification Process	36
	3.3 A Specimen Problem: Paramagnetic Molecules	45
4	Excitation Methods	51
5	Microwave Amplifier Systems	64
	5.1 The Line Amplifier – General Considerations	64
	5.2 Slow-Wave Structures	71
	5.3 Noise Temperature of the Maser Line Amplifie	r 75
	5.4 Resonant Cavity Maser Amplifier	80
	5.5 Noise Temperature of the Resonant Cavity	
	Maser	87
6	The Microwave Maser Oscillator	94
	6.1 Introduction	94
	6.2 Conditions for Oscillation: Emitted Power	97
	6.3 The Frequency of Oscillation	100

v

Contents

7	7 Infra-Red and Optical Masers	page 110
	7.1 General Considerations	110
	7.2 The Parallel Plate Resonator – Elementary	
	Treatment	113
	7.3 Optical Waveguide	117
8	3 Experimental Work	120
	8.1 Early Gaseous Devices: Amplification and Oscillation	120
	8.2 Gaseous Devices: Noise Temperature	127
	8.3 Early Solid-State Devices: Amplification Oscillation	and 132
	8.4 Solid-State Devices: Noise Temperature	138
	8.5 A Practical Microwave Line Amplifier	142
	8.6 A Practical Microwave Cavity Amplifier	145
	8.7 Infra-Red and Optical Masers	146
9	Applications and Future Work	154
	9.1 Applications	154
	9.2 Future Work: Materials	159
	9.3 Techniques	161
	9.4 Conclusion	162
	Acknowledgements	164
	Bibliography	165
	References	167
	Appendix I – Quantum Mechanical Treatmen the Harmonic Oscillator	t of 174
	Appendix II – Introduction to the Theory Paramagnetic Ions in a Crystal Field and a Ste	ady
	Magnetic Field	181
	Index	189

vi