

CONTENTS

<i>Preface</i>	v
<i>Chapter 1.</i> INTRODUCTION AND ELEMENTARY REVIEW OF THE STRUCTURE OF ATOMS AND MOLECULES	1
1.0. Introduction	1
1.1. Properties of atoms	2
1.2. One electron atom and ions	3
1.3. Fine structure	6
1.4. Hyperfine corrections and the Lamb shift	7
1.5. Structure of many electron atoms	8
1.6. Residual interactions and excited atomic levels	12
1.7. LS coupling	13
1.8. Configuration mixing	16
1.9. $j-j$ coupling	17
1.10. Molecular structure	17
1.11. Chemical bonding	18
1.12. Single particle molecular states	19
1.13. Coupling of the electrons in single particle orbitals	20
1.14. Vibrational and rotational excited states	22
1.15. Combining the electronic, vibrational and rotational energies	25
<i>Chapter 2.</i> THE INTERACTION OF ELECTROMAGNETIC RADIATION WITH ATOMS	28
2.0. Introduction	28
2.1. Planck's law and the quantization of the radiation field	28
2.2. Einstein coefficients and stimulated emission	33
2.3. Properties of the Einstein coefficients	35
2.4. Time-dependent wave equation	37
2.5. The Hamiltonian for an atom in an electromagnetic field	43
2.6. Properties of an electromagnetic plane wave	49
2.7. Transition probability for absorption	50

2.8.	Coupled equations with radiative damping	56
2.9.	Widths and profiles of spectral lines	59
2.10.	Spontaneous and stimulated emission	70
2.11.	Higher order multipole terms	72
2.12.	Selection rules and transition rates	75
2.13.	Angular distributions of the radiation	80
<i>Chapter 3.</i>	LIGHT AMPLIFICATION	84
3.0.	Introduction	84
3.1.	General equation for the absorption coefficient in terms of the level populations	84
3.2.	Population inversion: general equation for amplification for homogeneous transitions	88
3.3.	Gain curve for inhomogeneous transitions	93
3.4.	Line narrowing and amplified spontaneous emission	98
3.5.	Anomalous dispersion	101
3.6.	The laser cavity	102
3.7.	Threshold condition for laser oscillation: Q value	103
3.8.	Longitudinal cavity modes	106
3.9.	Transverse mode structure	111
3.10.	Gaussian optics	117
3.11.	Optical properties of laser cavities	120
3.12.	Mode frequencies	124
3.13.	Saturation effects and laser output power	126
<i>Chapter 4.</i>	SPECIAL TOPICS	135
4.0.	Introduction	135
4.1.	Three level laser system	135
4.2.	Four level systems	141
4.3.	Time-dependent solutions and Q -switching	142
4.4.	Mode locking	149
4.5.	Spatial hole burning	152
4.6.	Linewidth of a single mode laser	153
<i>Chapter 5.</i>	SOLID AND LIQUID LASERS	155
5.0.	Introduction	155
5.1.	Doped insulator lasers	156
5.2.	Optical modulators	169
5.3.	Semiconductor lasers	173
5.4.	Dye lasers	185

<i>Chapter 6.</i>	GAS LASERS	194
6.0.	Introduction	194
6.1.	Population inversion mechanisms in gas discharges	194
6.2.	Helium-neon laser	197
6.3.	Other atomic lasers	202
6.4.	CO ₂ laser	202
6.5.	Molecular nitrogen laser	208
6.6.	Excimer lasers	210
6.7.	Copper vapour laser	215
6.8.	Ion lasers	216
6.9.	Chemical lasers	222
6.10.	Gas dynamic lasers	223
<i>Index</i>	.	227