

## PRINCIPLES OF LASERS AND OPTICS

*Principles of Lasers and Optics* describes both the fundamental principles of lasers and the propagation and application of laser radiation in bulk and guided wave components. All solid state, gas and semiconductor lasers are analyzed uniformly as macroscopic devices with susceptibility originated from quantum mechanical interactions to develop an overall understating of the coherent nature of laser radiation.

The objective of the book is to present lasers and applications of laser radiation from a macroscopic, uniform point of view. Analyses of the unique properties of coherent laser light in optical components are presented together and derived from fundamental principles, to allow students to appreciate the differences and similarities. Topics covered include a discussion of whether laser radiation should be analyzed as natural light or as a guided wave, the macroscopic differences and similarities between various types of lasers, special techniques, such as super-modes and the two-dimensional Green's function for planar waveguides, and some unusual analyses.

This clearly presented and concise text will be useful for first-year graduates in electrical engineering and physics. It also acts as a reference book on the mathematical and analytical techniques used to understand many opto-electronic applications.

WILLIAM S. C. CHANG is an Emeritus Professor of the Department of Electrical and Computer Engineering, University of California at San Diego. A pioneer of microwave laser and optical laser research, his recent research interests include electro-optical properties and guided wave devices in III–V semiconductor hetero-junction and multiple quantum well structures, opto-electronics in fiber networks, and RF photonic links.

Professor Chang has published over 150 research papers on optical guided wave research and five books. His most recent book is *RF Photonic Technology in Optical Fiber Links* (Cambridge University Press, 2002).

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William S. C. Chang  
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# PRINCIPLES OF LASERS AND OPTICS

WILLIAM S. C. CHANG

*Professor Emeritus  
Department of Electrical Engineering and Computer Science  
University of California San Diego*





## Contents

<i>Preface</i>	<i>page</i> xi
1 Scalar wave equations and diffraction of laser radiation	1
1.1 Introduction	1
1.2 The scalar wave equation	3
1.3 The solution of the scalar wave equation by Green's function – Kirchhoff's diffraction formula	5
1.3.1 The general Green's function $G$	6
1.3.2 Green's function, $G_1$ , for $U$ known on a planar aperture	7
1.3.3 Green's function for $\nabla U$ known on a planar aperture, $G_2$	11
1.3.4 The expression for Kirchhoff's integral in engineering analysis	11
1.3.5 Fresnel and Fraunhofer diffraction	12
1.4 Applications of the analysis of TEM waves	13
1.4.1 Far field diffraction pattern of an aperture	13
1.4.2 Fraunhofer diffraction in the focal plane of a lens	18
1.4.3 The lens as a transformation element	21
1.4.4 Integral equation for optical resonators	24
1.5 Superposition theory and other mathematical techniques derived from Kirchhoff's diffraction formula	25
<i>References</i>	32
2 Gaussian modes in optical laser cavities and Gaussian beam optics	34
2.1 Modes in confocal cavities	36
2.1.1 The simplified integral equation for confocal cavities	37
2.1.2 Analytical solutions of the modes in confocal cavities	38
2.1.3 Properties of resonant modes in confocal cavities	39
2.1.4 Radiation fields inside and outside the cavity	45

vi	<i>Contents</i>	
	2.1.5 Far field pattern of the TEM modes	46
	2.1.6 General expression for the TEM <sub>lm</sub> modes	46
	2.1.7 Example illustrating the properties of confocal cavity modes	47
2.2	Modes in non-confocal cavities	48
	2.2.1 Formation of a new cavity for known modes of confocal resonators	49
	2.2.2 Finding the virtual equivalent confocal resonator for a given set of reflectors	50
	2.2.3 Formal procedure to find the resonant modes in non-confocal cavities	52
	2.2.4 Example of resonant modes in a non-confocal cavity	53
2.3	Gaussian beam solution of the vector wave equation	54
2.4	Propagation and transformation of Gaussian beams (the ABCD matrix)	57
	2.4.1 Physical meaning of the terms in the Gaussian beam expression	57
	2.4.2 Description of Gaussian beam propagation by matrix transformation	58
	2.4.3 Example of a Gaussian beam passing through a lens	61
	2.4.4 Example of a Gaussian beam passing through a spatial filter	62
	2.4.5 Example of a Gaussian beam passing through a prism	64
	2.4.6 Example of focusing a Gaussian beam	66
	2.4.7 Example of Gaussian mode matching	67
2.5	Modes in complex cavities	68
	2.5.1 Example of the resonance mode in a ring cavity	69
	<i>References</i>	71
3	Guided wave modes and their propagation	72
	3.1 Asymmetric planar waveguides	74
	3.1.1 TE and TM modes in planar waveguides	75
	3.2 TE planar waveguide modes	77
	3.2.1 TE planar guided wave modes	77
	3.2.2 TE planar guided wave modes in a symmetrical waveguide	78
	3.2.3 Cut-off condition for TE planar guided wave modes	80
	3.2.4 Properties of TE planar guided wave modes	81
	3.2.5 TE planar substrate modes	83
	3.2.6 TE planar air modes	83

<i>Contents</i>		vii
3.3	TM planar waveguide modes	85
3.3.1	TM planar guided wave modes	85
3.3.2	TM planar guided wave modes in a symmetrical waveguide	86
3.3.3	Cut-off condition for TM planar guided wave modes	87
3.3.4	Properties of TM planar guided wave modes	87
3.3.5	TM planar substrate modes	89
3.3.6	TM planar air modes	89
3.4	Generalized properties of guided wave modes in planar waveguides and applications	90
3.4.1	Planar guided waves propagating in other directions in the $yz$ plane	91
3.4.2	Helmholtz equation for the generalized guided wave modes in planar waveguides	91
3.4.3	Applications of generalized guided waves in planar waveguides	92
3.5	Rectangular channel waveguides and effective index analysis	98
3.5.1	Example for the effective index method	102
3.5.2	Properties of channel guided wave modes	103
3.5.3	Phased array channel waveguide demultiplexer in WDM systems	103
3.6	Guided wave modes in single-mode round optical fibers	106
3.6.1	Guided wave solutions of Maxwell's equations	107
3.6.2	Properties of the guided wave modes	109
3.6.3	Properties of optical fibers	110
3.6.4	Cladding modes	111
3.7	Excitation of guided wave modes	111
	<i>References</i>	113
4	Guided wave interactions and photonic devices	114
4.1	Perturbation analysis	115
4.1.1	Fields and modes in a generalized waveguide	115
4.1.2	Perturbation analysis	117
4.1.3	Simple application of the perturbation analysis	119
4.2	Coupling of modes in the same waveguide, the grating filter and the acousto-optical deflector	120
4.2.1	Grating filter in a single-mode waveguide	120
4.2.2	Acousto-optical deflector, frequency shifter, scanner and analyzer	125

viii	<i>Contents</i>	
4.3	Propagation of modes in parallel waveguides – the coupled modes and the super-modes	130
4.3.1	Modes in two uncoupled parallel waveguides	130
4.3.2	Analysis of two coupled waveguides based on modes of individual waveguides	131
4.3.3	The directional coupler, viewed as coupled individual waveguide modes	133
4.3.4	Directional coupling, viewed as propagation of super-modes	136
4.3.5	Super-modes of two coupled non-identical waveguides	137
4.4	Propagation of super-modes in adiabatic branching waveguides and the Mach–Zehnder interferometer	138
4.4.1	Adiabatic Y-branch transition	138
4.4.2	Super-mode analysis of wave propagation in a symmetric Y-branch	139
4.4.3	Analysis of wave propagation in an asymmetric Y-branch	141
4.4.4	Mach–Zehnder interferometer	142
4.5	Propagation in multimode waveguides and multimode interference couplers	144
	<i>References</i>	148
5	Macroscopic properties of materials from stimulated emission and absorption	149
5.1	Brief review of basic quantum mechanics	150
5.1.1	Brief summary of the elementary principles of quantum mechanics	150
5.1.2	Expectation value	151
5.1.3	Summary of energy eigen values and energy states	152
5.1.4	Summary of the matrix representation	153
5.2	Time dependent perturbation analysis of $\psi$ and the induced transition probability	156
5.2.1	Time dependent perturbation formulation	156
5.2.2	Electric and magnetic dipole and electric quadrupole approximations	159
5.2.3	Perturbation analysis for an electromagnetic field with harmonic time variation	159
5.2.4	Induced transition probability between two energy eigen states	161
5.3	Macroscopic susceptibility and the density matrix	162
5.3.1	Polarization and the density matrix	163
5.3.2	Equation of motion of the density matrix elements	164

<i>Contents</i>		ix
5.3.3	Solutions for the density matrix elements	166
5.3.4	Susceptibility	167
5.3.5	Significance of the susceptibility	168
5.3.6	Comparison of the analysis of $\chi$ with the quantum mechanical analysis of induced transitions	169
5.4	Homogeneously and inhomogeneously broadened transitions	170
5.4.1	Homogeneously broadened lines and their saturation	171
5.4.2	Inhomogeneously broadened lines and their saturation	173
	<i>References</i>	178
6	Solid state and gas laser amplifier and oscillator	179
6.1	Rate equation and population inversion	179
6.2	Threshold condition for laser oscillation	181
6.3	Power and optimum coupling for CW laser oscillators with homogeneous broadened lines	183
6.4	Steady state oscillation in inhomogeneously broadened lines	186
6.5	$Q$ -switched lasers	187
6.6	Mode locked laser oscillators	192
6.6.1	Mode locking in lasers with an inhomogeneously broadened line	193
6.6.2	Mode locking in lasers with a homogeneously broadened line	196
6.6.3	Passive mode locking	197
6.7	Laser amplifiers	198
6.8	Spontaneous emission noise in lasers	200
6.8.1	Spontaneous emission: the Einstein approach	201
6.8.2	Spontaneous emission noise in laser amplifiers	202
6.8.3	Spontaneous emission in laser oscillators	205
6.8.4	The line width of laser oscillation	207
6.8.5	Relative intensity noise of laser oscillators	210
	<i>References</i>	211
7	Semiconductor lasers	212
7.1	Macroscopic susceptibility of laser transitions in bulk materials	214
7.1.1	Energy states	215
7.1.2	Density of energy states	215
7.1.3	Fermi distribution and carrier densities	216
7.1.4	Stimulated emission and absorption and susceptibility for small electromagnetic signals	218
7.1.5	Transparency condition and population inversion	221
7.2	Threshold and power output of laser oscillators	221
7.2.1	Light emitting diodes	223

7.3	Susceptibility and carrier densities in quantum well semiconductor materials	224
7.3.1	Energy states in quantum well structures	225
7.3.2	Density of states in quantum well structures	226
7.3.3	Susceptibility	227
7.3.4	Carrier density and Fermi levels	228
7.3.5	Other quantum structures	228
7.4	Resonant modes of semiconductor lasers	228
7.4.1	Cavities of edge emitting lasers	229
7.4.2	Cavities of surface emitting lasers	234
7.5	Carrier and current confinement in semiconductor lasers	236
7.6	Direct modulation of semiconductor laser output by current injection	237
7.7	Semiconductor laser amplifier	239
7.8	Noise in semiconductor laser oscillators	242
	<i>References</i>	243
	<i>Index</i>	245

## Preface

When I look back at my time as a graduate student, I realize that the most valuable knowledge that I acquired concerned fundamental concepts in physics and mathematics, quantum mechanics and electromagnetic theory, with specific emphasis on their use in electronic and electro-optical devices. Today, many students acquire such information as well as analytical techniques from studies and analysis of the laser and its light in devices, components and systems. When teaching a graduate course at the University of California San Diego on this topic, I emphasize the understanding of basic principles of the laser and the properties of its radiation.

In this book I present a unified approach to all lasers, including gas, solid state and semiconductor lasers, in terms of “classical” devices, with gain and material susceptibility derived from their quantum mechanical interactions. For example, the properties of laser oscillators are derived from optical feedback analysis of different cavities. Moreover, since applications of laser radiation often involve its well defined phase and amplitude, the analysis of such radiation in components and systems requires special care in optical procedures as well as microwave techniques. In order to demonstrate the applications of these fundamental principles, analytical techniques and specific examples are presented. I used the notes for my course because I was unable to find a textbook that provided such a compact approach, although many excellent books are already available which provide comprehensive treatments of quantum electronics, lasers and optics. It is not the objective of this book to present a comprehensive treatment of properties of lasers and optical components.

Our experience indicates that such a course can be covered in two academic quarters, and perhaps might be suitable for one academic semester in an abbreviated form. Students will learn both fundamental physics principles and analytical techniques from the course. They can apply what they have learned immediately to applications such as optical communication and signal processing. Professionals may find the book useful as a reference to fundamental principles and analytical techniques.