

# Theory of Dielectric Optical Waveguides

*DIETRICH MARCUSE*

Bell Laboratories  
Crawford Hill Laboratory  
Holmdel, New Jersey



ACADEMIC PRESS New York and London 1974  
*A Subsidiary of Harcourt Brace Jovanovich, Publishers*

# Contents

PREFACE	ix
<b>Chapter 1. The Asymmetric Slab Waveguide</b>	
1.1 Introduction	1
1.2 Geometrical Optics Treatment of Slab Waveguides	3
1.3 Guided Modes of the Asymmetric Slab Waveguide	7
1.4 Radiation Modes of the Asymmetric Slab Waveguide	19
1.5 Leaky Waves	31
1.6 Hollow Dielectric Waveguides	43
1.7 Rectangular Dielectric Waveguides	49
<b>Chapter 2. Weakly Guiding Optical Fibers</b>	
2.1 Introduction	60
2.2 Guided Modes of the Optical Fiber	62
2.3 Waveguide Dispersion and Group Velocity	78
2.4 Radiation Modes of the Optical Fiber	83
2.5 Cutoff and Total Internal Reflection	89

**Chapter 3. Coupled Mode Theory**

3.1	Introduction	95
3.2	Expansion in Terms of Ideal Modes	98
3.3	Expansion in Terms of Local Normal Modes	106
3.4	Perturbation Solution of the Coupled Amplitude Equations	111
3.5	Coupling Coefficients for the Asymmetric Slab Waveguide	116
3.6	Coupling Coefficients for the Optical Fiber	126

**Chapter 4. Applications of the Coupled Mode Theory**

4.1	Introduction	132
4.2	Slab Waveguide with Sinusoidal Deformation	133
4.3	Hollow Dielectric Waveguide with Sinusoidal Deformation	145
4.4	Fiber with Sinusoidal Diameter Changes	153
4.5	Change of Polarization	157
4.6	Fiber with More General Interface Deformations	160
4.7	Rayleigh Scattering	167

**Chapter 5. Coupled Power Theory**

5.1	Introduction	173
5.2	Derivation of Coupled Power Equations	175
5.3	cw Operation of Multimode Waveguides	181
5.4	Power Fluctuations	193
5.5	Pulse Propagation in Multimode Waveguides	201
5.6	Diffusion Theory of Coupled Modes	227
5.7	Power Coupling between Waves Traveling in Opposite Directions	237

References	247
------------	-----

INDEX	251
-------	-----