Contents

1.	A Tu	torial .	Introduction. By R. Petit (With 13 Figures)		
	1.1	Prelim	inaries		
		1.1.1	General Notations		
		1.1.2	Time-Harmonic Maxwell Equations		
		1.1.3	Boundary Conditions		
		1.1.4	Electromagnetism and Distribution Theory		
		1.1.5	Notations Used in the Description of a Grating		
	1.2	The Perfectly Conducting Grating			
		1.2.1	Generalities		
		1.2.2	The Diffracted Field		
		1.2.3	The Rayleigh Expansion and the Grating Formula		
		1.2.4	An Important Lemma		
		1.2.5	The Reciprocity Theorem		
		1.2.6	The Conservation of Energy		
		1.2.7	The Littrow Mounting 14		
		1.2.8	The Determination of the Coefficients B _n by the		
			Rayleigh Method		
		1.2.9	An Integral Expression of u ^d in P Polarization		
		1.2.10	The Integral Method in P Polarization 2		
		1.2.11	The Integral Method in S Polarization 20		
		1.2.12	Modal Expansion Methods		
		1.2.13	Conical Diffraction 3		
	1.3	The Di	electric or Metallic Grating		
		1.3.1	Generalities		
		1.3.2	The Diffracted Field Outside the Groove Region 3		
		1.3.3	Maxwell Equations and Distributions		
		1.3.4	The Principle of the Differential Method (in P Polarization) . 3		
	1.4	Miscel	laneous 3		
	Refe	rences	4		
	Appe	ndix A:	The Distributions or Generalized Functions 4		
	A.1	Prelim	inaries 4		
	A.2 The Function Space R				
	АЗ	The Sn	ace R ¹ 4.		



		A.3.1 Definitions	43			
		A.3.2 Examples of Distributions	43			
	A.4	Derivative of a Distribution	44			
	A.5	Expansion with Respect to the Basis				
		$e_{i}(x) = \exp[i(nK+k \sin\theta)x] = \exp(i\alpha_{n}x)$	47			
		A.5.1 Theorem	47			
		A.5.2 Proof	48			
		A.5.3 Application to $\delta_{\mathcal{R}}$	49			
	A.6	Convolution	49			
		A.6.1 Memoranda on the Product of Convolution in \mathcal{D}_1^+	49			
		A.6.2 Convolution in R'	50			
2.	Some	me Mathematical Aspects of the Grating Theory. By M. Cadilhac				
	2.1	Some Classical Properties of the Helmholtz Equation	53			
	2.2	The Radiation Condition for the Grating Problem	54			
	2.3	A Lemma	55			
	2.4	Uniqueness Theorems	56			
		2.4.1 Metallic Grating, with Infinite Conductivity	56			
		2.4.2 Dielectric Grating	57			
	2.5	Reciprocity Relations				
	2.6	Foundation of the Yasuura Improved Point-Matching Method	59			
		2.6.1 Definition of a Topological Basis	59			
		2.6.2 The System of Rayleigh Functions is a Topological Basis	60			
		2.6.3 The Convergence of the Rayleigh Series; A Counterexample	61			
	Refe	rences	62			
3.	Integ	Integral Methods. By D. Maystre (With 8 Figures)				
	3.1	Development of the Integral Method	63			
	3.2	Presentation of the Problem and Intuitive Description of an				
		Integral Approach	65			
		3.2.1 Presentation of the Problem	65			
		3.2.2 Intuitive Description of an Integral Approach	66			
	3.3	Notations, Mathematical Problem and Fundamental Formulae	67			
		3.3.1 Notations and Mathematical Formulation	67			
		3.3.2 Basic Formulae of the Integral Approach	69			
	3.4	The Uncoated Perfectly Conducting Grating	71			
		3.4.1 The TE Case of Polarization	72			
		3.4.2 The TM Case of Polarization	74			
	3.5	The Uncoated Dielectric or Metallic Grating	76			
		3.5.1 The Mathematical Boundary Problem	76			
		3.5.2 Vital Importance of the Choice of a Well-Adapted				
		Unknown Function	77			

		3.5.3	Mathematical Definition of the Unknown Function and	
			Determination of the Field and Its Normal Derivative	
			Above P	77
		3.5.4	Expression of the Field in M_2 as a Function of ϕ	79
		3.5.5	Integral Equation	79
		3.5.6	Limit of the Equation when the Metal Becomes Perfectly	
			Conducting	80
	3.6	The Mu	ltiprofile Grating	81
	3.7	The Gr	ating in Conical Diffraction Mounting	85
	3.8	Numeri	cal Application	89
		3.8.1	A Fundamental Preliminary Choice	89
		3.8.2	Study of the Kernels	90
		3.8.3	Integration of the Kernels	93
		3.8.4	Particular Difficulty Encountered with Materials of	
			High Conductivity	96
		3.8.5	The Problem of Edges	98
		3.8.6	Precision on the Numerical Results	98
	Refe	rences		100
4.	Diff	erentia	l Methods. By P. Vincent (With 11 Figures)	101
	4.1	Introd	uctory Remarks	102
		4.1.1	Historical Survey	102
		4.1.2	Definition of Problem	102
	4.2	The E	Case	103
		4.2.1	The Reflection and Transmission Matrices	104
		4.2.2	The Computation of Transmission and Reflection Matrices	105
		4.2.3	Numerical Algorithms	106
		4.2.4	Alternative Matching Procedures for Some Grating Profiles	108
		4.2.5	Field of Application	108
	4.3		Case	109
		4.3.1	The Propagation Equation	109
		4.3.2	Numerical Treatment	110
		4.3.3	Field of Application	111
	4.4	The Ge	neral Case (Conical Diffraction Case)	111
		4.4.1	The Reflection and Transmission Matrices	112
		4.4.2	The Differential System	112
		4.4.3	Matching with Rayleigh Expansions	114
		4.4.4	Field of Application	114
	4.5	Strati	fied Media	115
		4.5.1	Stack of Gratings	115
		4.5.2	Plane Interfaces Between Homogeneous Media	116
			▼	

	4.6	Infini	tely Conducting Gratings: the Conformal Mapping Method	117	
		4.6.1	Method	117	
		4.6.2	Determination of the Conformal Mapping	119	
		4.6.3	Field of Application	121	
	Refe	rences		121	
5.	The	Homogen	eous Problem. By M. Nevière (With 25 Figures)	123	
	5.1	Histor	ical Summary	124	
	5.2	Plasmo	n Anomalies of a Metallic Grating	126	
		5.2.1	Reflection of a Plane Wave on a Plane Interface	126	
		5.2.2	Reflection of a Plane Wave on a Grating	130	
	5.3	Anoma1	ies of Dielectric Coated Reflection Gratings Used in		
		TE Pol	arization	136	
		5.3.1	Determination of the Leaky Modes of a Dielectric Slab		
			Bounded by Metal on One of Its Sides	137	
		5.3.2	Reflection of a Plane Wave on a Dielectric Coated Reflection		
			Grating Used in TE Polarization	140	
	5.4	Extens	ion of the Theory	143	
		5.4.1	Anomalies of a Dielectric Coated Grating Used in		
			TM Polarization	143	
		5.4.2	Plasmon Anomalies of a Bare Grating Supporting Several		
			Spectral Orders	145	
		5.4.3	General Considerations on Anomalies of a Grating Supporting		
			Several Spectral Orders	148	
	5.5	Theory	of the Grating Coupler	149	
		5.5.1	Description of the Incident Beam	150	
		5.5.2	Response of the Structure to a Plane Wave	151	
		5.5.3	Response of the Structure to a Limited Beam	153	
		5.5.4	Determination of the Coupling Coefficient	154	
		5.5.5	Application to a Limited Incident Beam	155	
	Refe	rences	•••••	156	
6.	Ехре	erimento	al Verifications and Applications of the Theory		
	By D. Maystre, M. Nevière and R. Petit (With 105 Figures)				
	6.1	Experi	imental Checking of Theoretical Results	159	
		6.1.1	Generalities	159	
		6.1.2	Microwave Region	160	
		6.1.3	On the Determination of Groove Geometry and of the		
			Refractive Index	160	
		6.1.4	Infrared	164	
		6.1.5	Visible Region	165	
		6.1.6	Near and Vacuum UV	170	

				171		
		6.1.7	XUV Domain	171		
		6.1.8	X-Ray Domain	172		
	6.2		atic Study of the Efficiency of Perfectly Conducting Gratings .	173		
		6.2.1		174		
			Mount	174		
		6.2.2	An Equivalence Rule Between Ruled, Holographic, and	101		
			Lamellar Gratings	181		
		6.2.3	Systematic Study of the Efficiency of Holographic Gratings	104		
			in -1 Order Littrow Mount	184		
		6.2.4	Systematic Study of the Efficiency of Symmetrical Lamellar	100		
			Gratings in -1 Order Littrow Mount	188		
		6.2.5	Influence of the Apex Angle	190		
		6.2.6	Influence of a Departure from Littrow	191		
		6.2.7	Higher Order Use of Gratings	194		
	6.3	Finite	Conductivity Gratings	198		
		6.3.1	General Rules	198		
		6.3.2	Typical Efficiency Curves in the Visible Region	201		
		6.3.3	Influence of Dielectric Overcoatings in Vacuum UV	202		
		6.3.4	The Use of Gratings in XUV and X-Ray Regions ($\lambda < 1000$ Å)	205		
		6.3.5	Conical Diffraction Mountings	209		
	6.4	Some P	articular Applications	212		
		6.4.1	Simultaneous Blazing in Both Polarizations	212		
		6.4.2	Spectrometers with Constant Efficiency	213		
		6.4.3	Grating Bandpass Filter	214		
		6.4.4	Reflection Grating Polarizer for the Infrared	216		
		6.4.5	Transmission Gratings as Masks in Photolithography	216		
		6.4.6	Gratings Used as Beam Sampling Mirrors for High			
			Power Lasers	218		
		6.4.7	Gratings as Wavelength Selectors in Tunable Lasers	220		
		6.4.8	Transmission Dielectric Gratings used as Color Filters	221		
	Conc	ludina	Remarks	223		
		erences				
7.	The	om of l	Crossed Gratings			
′ •	Rv I	R.C. McI	Phedran, G.H. Derrick, and L.C. Botten (With 20 Figures)	227		
	7.1	Overv	iew	227		
	7.2	The B	igrating Equation and Rayleigh Expansions	228		
	7.3 Inductive Grids					
	,	7.3.1	A Company of the Comp	233		
		7.3.2				
		7.3.2	The state of the s			

7.4	Capaci	tive and Other Grid Geometries	242
	7.4.1	High-Pass Filters	243
	7.4.2	Low-Pass Filters	243
	7.4.3	Bandpass Filters	243
	7.4.4	Bandstop Filters	244
7.5	Spatia	1ly Separated Grids or Gratings	244
	7.5.1	The Crossed Lamellar Transmission Grating	245
	7.5.2	The Double Grating	247
	7.5.3	Symmetry Properties of Double Gratings	251
	7.5.4	Multielement Grating Interference Filters	255
7.6	Finite	ly Conducting Bigratings	258
	7.6.1	A Short Description of the Method	258
	7.6.2	The Coordinate Transformation	259
	7.6.3	Integral Equation Form	262
	7.6.4	Iterative Solution of the Integral Equations	266
	7.6.5	Total Absorption of Unpolarized Monochromatic Light	267
	7.6.6	Reduction of Metallic Reflectivity: Plasmons and Moth-Eyes	269
	7.6.7	Equivalence Formulae Linking Crossed and Classical Gratings	271
	7.6.8	Coated Bigratings	273
Refe			275
Additio	nal Ref	erences with Titles	277
Subject			281
ιμω, ι ε ι ι ι	11111111	* * * * * * * * * * * * * * * * * * * *	