CONTENTS

•	face ide to Course Adoption		v ix
Cha	apter 1 Compatible Transf	orms	1
1.1	The Method of Separatio	n of Variables and the Integral	
	Transforms		2
	1.1.1 Integral Transforms	;	6
1.2	Compatible Transforms		7
	1.2.1 Examples of Comp	atible Transforms	10
	1.2.2 Nonlinear Terms		20
1.3	Classification of the Trans	forms	20
	1.3.1 Integral Transforms	3	21
	1.3.2 Band-Limited Fund	tions (or Transforms)	21
	1.3.3 Finite Transforms-	-the Fourier Coefficients	23
	1.3.4 The Truncation and	d Discretization (Sampling) Errors	26
	1.3.5 The Discrete Trans		27
1.4		e Transforms—Tables of the	
	Transforms		29
	1.4.1 Integral Equations-	-Basic Definitions	30
1.5	The Compatible Transform	m and the Adjoint Problem	30
1.0	1.5.1 The Adjoint Differ		32
	1.5.2 The Two Eigenvalu		36

XII CONTENTS

1.6	Constructing the Compatible Transforms for Self-Adjoint			
		ems—Second-Order Differential Equations	49	
	1.6.1	Examples of the Sturm-Liouville and Other		
		Transforms—Boundary Value Problems	52	
	1.6.2		56	
1.7	The n	th-Order Differential Operator	58	
	Relev	ant References to Chapter 1	63	
	Exerc	ises	63	
Cha	pter 2	Integral Transforms	81	
2.1	Lapla	ce Transforms	82	
	2.1.1		91	
	2.1.2	The Convolution Theorem for Laplace Transforms	104	
	2.1.3	Solution of Initial Value Problems Associated with		
		Ordinary and Partial Differential Equations	111	
	2.1.4	11		
		Difference Kernels	121	
		The z-Transform	127	
2.2		er Exponential Transforms	128	
	2.2.1	Existence of the Fourier Transform and Its		
		Inverse—the Fourier Integral Formula	132	
	2.2.2	Basic Properties and the Convolution Theorem	157	
2.3	Boundary and Initial Value Problems—Solutions by Fourier Transforms			
			171	
	2.3.1	The Heat Equation on an Infinite Domain	171	
		The Wave Equation	174	
		The Schrödinger Equation	176	
2.4		The Laplace Equation	181	
2.4	Signal	Tropiesonation in the Fourier		
	· •	trum) Space	183	
		Linear Systems	184	
	2.4.2 2.4.3	mo being Expulsion	204	
2.5		Bandlimited Functions and B-Splines (Hill Functions) er Sine and Cosine Transforms	212	
2.5	2.5.1		213	
	2.3.1	i de la constanta de constanta con la constanta constanta con la constanta con la constanta constanta con la constanta constanta constanta con la constanta constanta con la constanta constanta constanta constanta constanta con la constanta con la constanta con la constanta constanta constanta constanta constanta constanta con la constanta constanta con la constanta con la constanta constant		
	2.5.2	Transforms with Even-Order Derivatives	216	
	2.3.2	Applications to Boundary Value Problems on Semi-Infinite Domain	210	
2.6	Highe	r-Dimensional Fourier Transforms	219	
2.0	2.6.1	Relation Between the Hankel Transform and the	224	
	4.0.1	Multiple Fourier Transform Co. 1 C		
		Multiple Fourier Transform—Circular Symmetry	231	

		CONTENTS	XIII
	2.6.2	The Double Fourier Transform of Functions with	
		Circular Symmetry—The J ₀ -Hankel Transform	233
	2.6.3	A Double Fourier Transform Convolution Theorem	
		for the J_0 -Hankel Transform	236
2.7	The I	Hankel (Bessel) Transforms	236
	2.7.1	`	242
2.8		ce Transform Inversion	251
	2.8.1	Fourier Transform in the Complex Plane	251
	2.8.2		253
	2.8.3		254
		Applications	255
2.9		Important Integral Transforms	257
	2.9.1	Hilbert Transform	257
		Mellin Transform	257
		The z-Transform and the Laplace Transform	258
		ant References for Chapter 2	261
	Exerc		261
Cha	pter 3	Finite Transforms-Fourier Series and Coefficients	329
3.1	Fouri	er (Trigonometric) Series and General Orthogonal	
	Expai		332
	3 1 1	Convergence of the Fourier Series	343
	312	Flements of Infinite Series—Convergence Theorems	372
	3.1.3	The Orthogonal Expansions—Bessel's Inequality and	
		Fourier Series	384
3.2	Fouri	er Sine and Cosine Transforms	421
3.3	Fouri	er (Evnonential) Transforms	427
	3.3.1	The Finite Fourier Exponential Transform and the	
		Sampling Expansion	429
3.4	Hank	el (Bessel) Transforms	433
	3.4.1	Another Finite Hankel Transform	437
3.5	Class	ical Orthogonal Polynomial Transforms	440
	3.5.1	Legendre Transforms	441
		Laguerre Transform	445
	3 5 3	Hermite Transforms	446
		Tchebychev Transforms	447
3.6	The f	Congressized Sampling Expansion	449
٥.0	361	Generalized Translation and Convolution Products	452
	3.6.2	Impulse Train for Ressel Orthogonal Series Expansion	
	J.U.2	for a (New) Bessel-Type Poisson Summation Formula	456

XIV CONTENTS

3.7	A Remark on the Transform Methods and Nonlinear		
	Proble		461
	Releva	ant References to Chapter 3	464
	Exerc		465
Cha	pter 4	Discrete Transforms	509
4.1	Discre	ete Fourier Transforms	510
	4.1.1	Fourier Integrals, Series, and the Discrete Transforms	514
	4.1.2	Computing for Complex-Valued Functions	532
	4.1.3	The Fast Fourier Transform	547
	4.1.4	Construction and Basic Properties of the Discrete	
		Transforms	553
	4.1.5	Operational Difference Calculus for the DFT and	
		the z-Transform	573
	4.1.6		
		Discrete Fourier Transforms	593
		Examples of Computing Fourier Integrals and Series	637
4.2		ete Orthogonal Polynomial Transforms	645
		Basic Properties and Illustrations	646
	4.2.2	1	649
	4.2.3	and the second second second to ynome.	
		Transforms	651
4.3		1-type Poisson Summation Formula (for the	
	Besse	I-Fourier Series and Hankel Transforms)	656
	Relev	ant References for Chapter 4	662
	Exerc	ises	663
Арр	endix A	A Basic Second-Order Differential Equations and	
		Their (Series) Solutions—Special Functions	689
A .1	Intro	duction	689
A.2	Meth	od of Variation of Parameters	691
A .3	Powe	r Series Method of Solution	694
A.4	Frobenius Method of Solution—Power Series Expansion		
		it a Regular Singular Point	699
A. 5	Speci	al Differential Equations and Their Solutions	702
	A .5.1	Bessel's Equation	703
	A.5.2	Legendre's Equation	705
	A.5.3	Other Special Equations	710
	Exercises		713

Appendix B Mathematical Modeling of Partial Differential Equations—Boundary and Initial Value Problems		
B.1	Partial Differential Equations for Vibrating Systems	742
	Diffusion (or Heat Conduction) Equation	748
	Exercises	752
Appei	ndix C Tables of Transforms	765
C.1	Laplace Transforms	766
C.2	Fourier Exponential Transforms	769
C.3	Fourier Sine Transforms	773
C.4	Fourier Cosine Transforms	777
C.5	Hankel Transforms	780
C.6	Mellin Transforms	782
C.7	Hilbert Transforms	783
C.8	Finite Exponential Transforms	784
C.9	Finite Sine Transforms	785
C.10	Finite Cosine Transforms	788
C.11	Finite (First) Hankel Transforms, $J_n(\lambda_k a) = 0$	792
C.12	Finite (Second) Hankel Transforms,	
	$\lambda_k J_n'(\lambda_k a) + h J_n(\lambda_k a) = 0$	793
C.13		794
C.14	Finite Tchebychev Transforms	790
C.15	Finite Laguerre Transforms	790
C.16		790
C.17	z-Transforms	79
Biblic	ography	79
Index of Notations		809
	ect Index	813