CONTENTS

CHAPTER	1. Linear Differential Equations				
$1-1$ $\mathbf{E}_{\mathbf{X}}$	sistence theorem for linear differential equations .				1
1-2 So	lution of the homogeneous equation with constant co	· ·	iont		2
1–3 Lu	near differential equations with constant				2
1–4 Sir	coefficients; nonhomogeneous case				5
1-5 Sin	nultaneous linear differential equations				8
1-6 Int	nultaneous linear equations with constant coefficient egrodifferential equations				11
1-7 Co	regrodifferential equations				17
1-8 Dif	mplex functions of a real variable	• •	•		22
1-9 Co	ferentiation and integration of complex-valued funct	ions	of t		26
1-10 For	mplex solutions of linear differential equations				32
	a I PC circuit				38
1-12 Ros	enone to unit function and all 1	•			42
1-13 Im	sponse to unit function and other discontinuous inpu	ıts .	٠		44
1-14 An	pulse function and other generalized functions				49
I II Mp	plication of generalized functions to linear differential	l equ	atio	ns	56
CHAPTER 2 2-1 One	- Dister Concerts of Distems Analysis				
- F	erators			٠	64
2-3 Ope	rators associated with linear differential equations.	•	٠	•	66
2–4 Ope	rators associated with simultaneous linear differential	•		٠	70
2-5 Sup	erposition principle and interchange of operations	equa	itioi	ns	73
2-6 Tra	nslation and stationary systems	٠	٠	٠	79
2–7 Duh	namel's integral	•	•	٠	83
	ghting function, impulse response, convolution	•	•	٠	87
2-9 Cha	racteristic function, transfer function, frequency	•	٠	•	89
fu	nction	res	pons	se	
2-10 Stab					94
	niity	٠	•	•	103
Chapter 3.	Analytic Functions of a Complex Variable				
	ctions of a complex variable. Limits and continuity				100
3-2 Deri	vatives and differentials	•	٠	•	108
3-3 Integ	grals	•	٠	•	109
		•	•	•	112

viii contents

3–4	Analytic functions. Cauchy-Riemann equations	115
3-5	The functions $\log z$, a^z , z^a , $\sin^{-1} z$, $\cos^{-1} z$	121
3–6	Integrals of analytic functions. Cauchy integral theorem	125
3–7		129
3–8	Power series as analytic functions	132
3-9	Power series expansion of general analytic function	135
3-10	Power series in positive and negative powers, Laurent expansion .	139
3-11	Isolated singularities of an analytic function. Zeros and poles .	
3-12	The complex number ∞	146
3-13	Residues	150
	Residue at infinity	154
3–15	Logarithmic residues; argument principle	156
3–16	Partial fraction expansion of rational functions	158
Снарті	ER 4. FOURIER SERIES AND FINITE FOURIER TRANSFORM	
Снарт		
4–1	Response to a sum of sinusoidal terms	163
4-2	Periodic inputs. Fourier series	164
4–3	Examples of Fourier series	166
4–4	Uniform convergence	169
4-5	Uniqueness theorem for Fourier series	170
4–6	Uniformly convergent Fourier series	173
4-7	Convergence of Fourier series at a point	175
4-8	Convergence in the mean	180
4-9	Differentiation and integration of Fourier series	181
4-10	Change of period	184
4-11	Complex form of Fourier series	185
4–12	Orthogonal functions	187
4–13	Solution of differential equations by Fourier series	189
4–14	The finite Fourier transform	190
4-15	The truncated Laplace transform as an aid to computation of	
	finite Fourier transforms	192
4–16	Properties of the finite Fourier transform	198
4-17	Convolution	201
4-18	Special convolutions	203
4–19	The inverse finite Fourier transform	208
4-20	Finite Fourier transforms of generalized functions	211
4-21	Application of finite Fourier transforms to linear differential	
	equations	215
4-22	Proof of Theorem 23	219
	The weighting function	
	Response to periodic generalized functions	224

CONTENTS	ix
CONTENTS	IA

4-25	Systems of differential equations .									225
	Integrodifferential equations									230
4-27	Systems analysis for periodic inputs									232
Снарті	er 5. The Fourier Integral and Fo	OUF	RIER	TR	ANSF	ORM	ſ			
5–1	Introduction of the Fourier integral									235
5-2	Basic properties of the Fourier integra									236
5–3	Fourier transforms									238
5–4	Validity of the formulas									240
5–5	Examples of Fourier integrals									241
5-6	Uniform convergence for improper int	egr	als							245
5–7	Preliminary lemmas									245
5 –8	Proof of Theorem 2									248
5–9										252
5-10	Properties of the Fourier transform									252
5-11	Convolution									257
5-12	Special convolutions									263
	The inverse Fourier transform									270
5-14	Evaluation of inverse Fourier transfor	ms	by	resi	dues					271
	Proof of Theorem 18									276
5-16	Fourier transforms of generalized func	tio	ns							278
5-17	Application of Fourier transforms to	line	ear	diffe	erent	ial (equ	atio	ns	284
5–18	The weighting function						•			290
	Response to generalized functions as in									292
	Application of Fourier transforms t							enti	al	
	equations									295
5-21	Applications of Fourier transforms to									297
	Systems analysis by Fourier transform									298
Снарти	er 6. The Laplace Transform									
6–1	Introduction of the Laplace transform	ı								301
6–2	Relations between the Laplace transfor	m e	and	the	Four	ier t	ran	sfor	m	303
6–3	Examples of Laplace transforms									303
6-4	Theory of the Laplace transform									309
6–5	Properties of the Laplace transform									311
6–6	The Laplace transform as an analytic									316
6–7	Inverse transform									317
6–8	Evaluation of inverse transforms by re									323
6-9	Laplace transforms analytic at infinity									324
	Expansion in terms of Laguerre polynomials									
	Initial- and final-value theorems									336

X CONTENTS

6-12	2 Convolution	. 340
6-13	2 C	. 343
	4 T 1	353
6-15	5 Application of Laplace transforms to differential equations	356
	6 Examples	
6-17	7 The equation for forced vibrations	364
6-18	B Weighting function. Response to generalized functions	367
6-19	Application of Laplace transforms to simultaneous differentia	1
	equations	
6-20	Application of Laplace transforms to integrodifferential equations	372
6 – 21	System analysis by means of Laplace transforms	373
6 – 22	The z-transform	
6-23	B Application of the z-transform to difference equations	385
6-24	Sampled-data systems	388
6-25	Hilbert transforms	395
Снарт	er 7. Stability	
7–1	Introduction	403
7-2	Ciama of the and Ciamta	400
7-3	Direct method	404
7-4	Hurwitz-Routh criterion	
7-5	Proof of Hurwitz-Routh criterion	
7-6	Nyquist criterion. Polynomial case	
7-7	Stabilitar datamain ad from month of T7/1 \	
7–8	Nyquist criterion. Rational function case $\cdot \cdot \cdot$	419
7-9	Root-locus method	
	Properties of the root locus	
0	- 1 openies of the root locals	421
Снарти	er 8. Time-variant Linear Systems	
8-1	The linear differential equation of order n; the Wronskian	436
8-2	The generalized weighting function; the kernel function	439
8-3	Green's function; impulse response	442
8–4	Adjoint equation	448
8-5	Solution of linear differential equations by infinite series	453
8-6	Equations with coefficients asymptotic to constants	456
8-7	Perturbation method	466
8–8	Equations with coefficients which are piecewise constant	468
8-9	Application of Laplace transforms	470
8-10	Equations with periodic coefficients	472
8-11	Evaluation of characteristic exponents	477
8-12	The equation of second order with periodic coefficients	401

CONTENTA	•
CONTENTS	vi
	AL

8-13 Matrix for	nulation of dif	ferenti	al eq	uati	ons						490
8-14 Stability th	neorems										496
8-15 Application	of Hermitian	matric	ces								499
8–16 Response to	o bounded inp	uts .									503
8-17 Operationa	l methods .										515
Appendix I. Ti	he Operation	al Cai	LCULI	JS O	г N	11K	USII	ńsk	I		529
APPENDIX II. R	ECAPITULATION	ог Рг	RINCI	PAL	Та	BLE	s		•		541
APPENDIX III. G	LOSSARY OF SY	MBOLS									565
INDEX											569