## **CONTENTS**

1. THE CONCEPT OF FREQUENCY CONTENT

Trigonometric Sine and Cosine Functions	
Generalized Sine and Cosine Functions	
Degrees, Radians, and Grads	
Derivatives of the Sine and Cosine Functions	i
Amplitude, Frequency, and Phase	
	10
	1
Complex Representation of Frequency Content	20
Summary	30
Bibliography	30
THE FOURIER SERIES	31
	32
	34
	4(
· ·	42
•	44
Fourier Series of Odd and Even Functions	45
Politier Series of Lidd and Even Eunstions	1/2
	47
The Function $\sin 2\pi at$	51
	Degrees, Radians, and Grads Derivatives of the Sine and Cosine Functions Amplitude, Frequency, and Phase Concept of Frequency Content Complex Variable Tutorial Complex Representation of Frequency Content Summary Bibliography  THE FOURIER SERIES  Fourier Series Frequency Content Periodic Functions Complex Form of Fourier Series Properties of the Fourier Series Fourier Series of Complex Functions Additional Properties of the Fourier Series

3.	THE FOURIER TRANSFORM	55
	Fourier Transform Frequency Content	57
	Properties of the Fourier Transform	62
	The Gaussian Function	67
)	Convolution and Cross-Correlation	68
	Symmetry Relations	75 75
	The Impulse Function	75 80
	Two-Dimensional Fourier Transforms	81
	Properties in Two-Dimensions	82
	Separable and Radial Symmetric Functions	85
	Convolution in Two-Dimensions	86
	Summary Bibliography	87
4.	THE DISCRETE FOURIER TRANSFORM	89
	Nth Order Sequences	90
	The Discrete Fourier Transform	91
	Properties of the Discrete Fourier Transform	95
	Symmetry Relations	99
	Simultaneous Calculation of Real Transforms	100
	The Fast Fourier Transform	102
	Mixed Radix Fast Transforms	106
	Summary	108
	Bibliography	109
5.	FOURIER ANALYSIS VIA A DIGITAL COMPUTER	111
	Sampling a Function	112
	The Sampling Theorem	115
	Computer-Calculated Fourier Transforms	120
	Computer-Generated Fourier Series	127
	Sampling by Means of the Comb Function	131
	Super-Gaussian Windows	134
	Summary	147
	Bibliography	147
6.	SYSTEMS AND TRANSFER FUNCTIONS	149
	Concept of a System	149
	Impulse Response of a System	152

	CONTENTS	xi
	Transfer Function of a System	154
	Impulse Response and Transfer Functions	156
	Summary	157
	Bibliography	157
7.	VIBRATIONAL SYSTEMS	159
	Transfer Function of the General Equation	159
	Mechanical Systems	160
	Electrical Systems	170
	Transverse Vibration of an Infinite String	182
	Transverse Vibration of a Finite String	188 193
	Summary Bibliography	193
8.	OPTICS	195
	The Fresnel Diffraction Equation	195
	Fresnel Equation as a Fourier Transform	206
	Thin Lenses and Diffraction	217
	Imaging Properties of Lenses	223
	Coherent and Incoherent Optical Systems	234
	Resolution of Optical Systems	242
	Spatial Filtering	248
	Sampling Theory with Optics Applications	251
	Summary	256
	Bibliography	256
9.	NUMERICAL ANALYSIS	257
	Nonrecursive Algorithms	257
	Nonrecursive Smoothing Algorithms	261
	Derivative Algorithms	264
	Recursive Algorithms	272
	Finite Difference Calculus Review	275
	Integration Algorithms	278
	Interpolation Algorithms	286
	Synthesis of Nonrecursive Filters Summary	290 293
	Bibliography	293
		273

10.	THE HEAT EQUATION	295
	Derivation of the Heat Equation	295
	Finite Sine and Cosine Transforms	297
	One-Dimensional Heat Flow in Finite Bodies	299
	Two-Dimensional Steady State Heat Flow	310
	Two-Dimensional Transient Heat Flow	313
	Heat Flow in an Infinite One-Dimensional Body	316
	Summary	321
	Bibliography	321
11.	STOCHASTIC ANALYSIS	323
	Review of Statistics	323
	Review of Probability Theory	331
	Review of Correlation Theory	340
	Moments and the Central Limit Theorem	347
	Convolution and Probability Distributions	352
	Autocorrelation and Random Signals	355
	Ensembles and Expected Values of a Random Signal	360
	Systems and Random Signals	363
	Stationary Signals and the Ergodicity Principle	366
	Summary	368
	Bibliography	368
Inde	ex	369