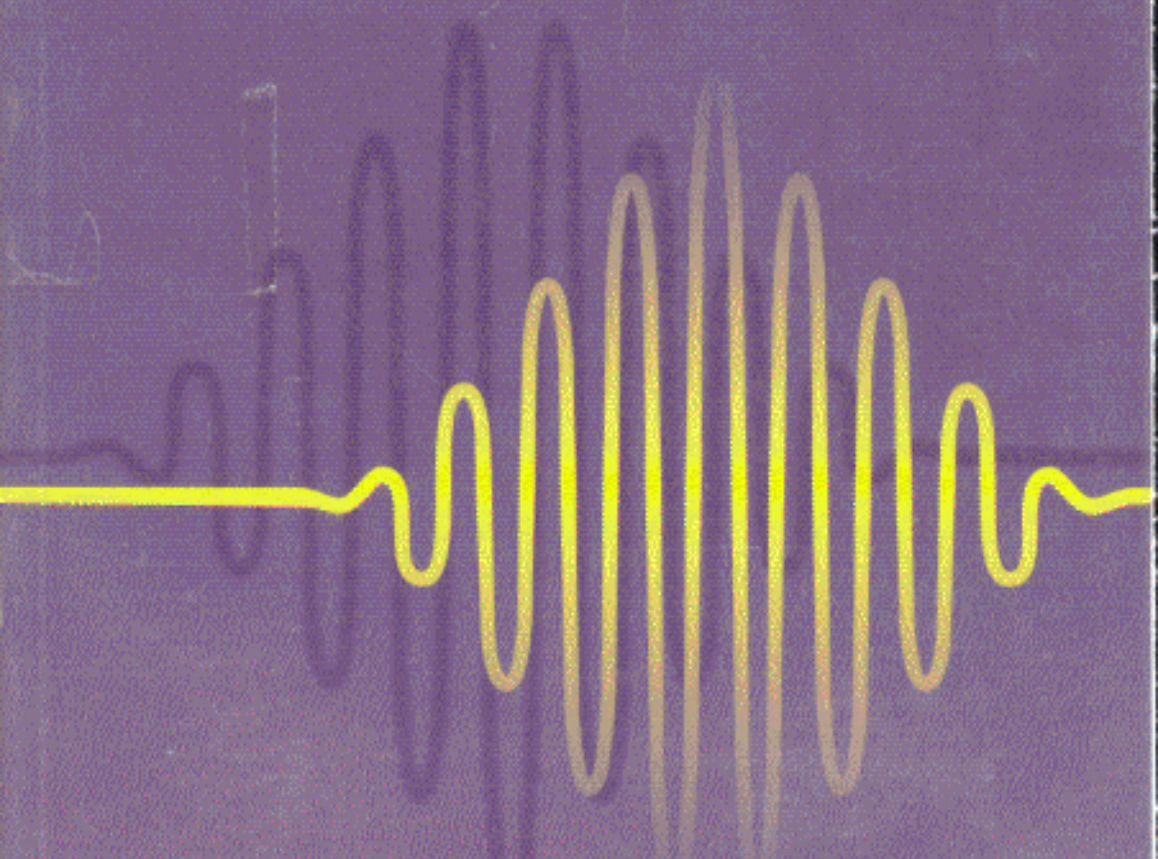


J. F. James

Second Edition

# A Student's Guide to Fourier Transforms

With Applications in Physics and Engineering



CAMBRIDGE

# Contents

<i>Preface to the first edition</i>	<i>page vii</i>
<i>Preface to the second edition</i>	<i>ix</i>
1 Physics and Fourier transforms	1
1.1 The qualitative approach	1
1.2 Fourier series	2
1.3 The amplitudes of the harmonics	4
1.4 Fourier transforms	8
1.5 Conjugate variables	10
1.6 Graphical representations	11
1.7 Useful functions	11
1.8 Worked examples	18
2 Useful properties and theorems	20
2.1 The Dirichlet conditions	20
2.2 Theorems	21
2.3 Convolutions and the convolution theorem	23
2.4 The algebra of convolutions	29
2.5 Other theorems	30
2.6 Aliasing	33
2.7 Worked examples	35
3 Applications 1: Fraunhofer diffraction	38
3.1 Fraunhofer diffraction	38
3.2 Examples	42
3.3 Polar diagrams	52
3.4 Phase and coherence	53
3.5 Exercises	57
4 Applications 2: signal analysis and communication theory	58
4.1 Communication channels	58
4.2 Noise	60
4.3 Filters	61
4.4 The matched filter theorem	62

4.5	Modulations	63
4.6	Multiplex transmission along a channel	69
4.7	The passage of some signals through simple filters	69
4.8	The Gibbs phenomenon	70
5	Applications 3: spectroscopy and spectral line shapes	76
5.1	Interference spectrometry	76
5.2	The shapes of spectrum lines	81
6	Two-dimensional Fourier transforms	86
6.1	Cartesian coordinates	86
6.2	Polar coordinates	87
6.3	Theorems	88
6.4	Examples of two-dimensional Fourier transforms with circular symmetry	89
6.5	Applications	90
6.6	Solutions without circular symmetry	92
7	Multi-dimensional Fourier transforms	94
7.1	The Dirac wall	94
7.2	Computerized axial tomography	97
7.3	A 'spike' or 'nail'	101
7.4	The Dirac fence	103
7.5	The 'bed of nails'	104
7.6	Parallel plane delta-functions	106
7.7	Point arrays	106
7.8	Lattices	107
8	The formal complex Fourier transform	109
9	Discrete and digital Fourier transforms	116
9.1	History	116
9.2	The discrete Fourier transform	117
9.3	The matrix form of the DFT	118
9.4	The BASIC FFT routine	122
	<i>Appendix</i>	126
	<i>Bibliography</i>	131