

Contents

<i>Foreword</i>	vii
<i>Prologue</i>	xv
Chapter 1 Classical Electrodynamics	1
1.1 Introductory Comments	1
1.2 Space and Time Dependence upon Speed	2
1.3 Four-Dimensional Space Time	4
1.4 Newton's Laws	6
1.5 Electrodynamics	7
1.6 The Field Equations	10
1.7 Accelerating Charges	13
1.8 The Electromagnetic Stress Tensor	14
1.9 Kinematic Properties of Fields	17
1.10 A Lemma for Calculation of Electromagnetic Fields	19
1.11 The Scalar Differential Equation	21
1.12 Radiation Fields in Spherical Coordinates	23
1.13 Electromagnetic Fields in a Box	26
1.14 From Energy to Electric Fields	29
References	30
Chapter 2 Selected Boundary Value Problems	31
2.1 Traveling Waves	32
2.2 Scattering of a Plane Wave by a Sphere	34
2.3 Lossless Spherical Scatterers	40
2.4 Biconical Transmitting Antennas, General Comments	45
2.5 Fields	47
2.6 TEM Mode	49
2.7 Boundary Conditions	52
2.8 The Defining Integral Equations	56
2.9 Solution of the Biconical Antenna Problem	58
2.10 Power	64
2.11 Biconical Receiving Antennas	67
2.12 Incoming TE Fields	71

2.13 Incoming TM Fields	71
2.14 Exterior Fields, Powers, and Forces	75
2.15 The Cross-Sections	80
2.16 General Comments	84
2.17 Fields of Receiving Antennas	86
2.18 Boundary Conditions	88
2.19 Zero Degree Solution	91
2.20 Non-Zero Degree Solutions	92
2.21 Surface Current Densities	94
2.22 Power	95
References	98
Chapter 3 Antenna Q	99
3.1 Instantaneous and Complex Power in Circuits	100
3.2 Instantaneous and Complex Power in Fields	103
3.3 Time Varying Power in Actual Radiation Fields	105
3.4 Comparison of Complex and Instantaneous Powers	108
3.5 Radiation Q	112
3.6 Chu's Q Analysis, TM Fields	115
3.7 Chu's Q Analysis, Exact for TM Fields	120
3.8 Chu's Q Analysis, TE Field	122
3.9 Chu's Q Analysis, Collocated TM and TE Modes	123
3.10 Q the Easy Way, Electrically Small Antennas	124
3.11 Q on the Basis of Time-Dependent Field Theory	125
3.12 Q of a Radiating Electric Dipole	131
3.13 Q of Radiating Magnetic Dipoles	136
3.14 Q of Collocated Electric and Magnetic Dipole Pair	137
3.15 Q of Collocated Pairs of Dipoles	140
3.16 Four Collocated Electric and Magnetic Multipoles	144
3.17 Q of Multipolar Combinations	148
3.18 Numerical Characterization of Antennas	152
3.19 Experimental Characterization of Antennas	158
3.20 Q of Collocated Electric and Magnetic Dipoles: Numerical and Experimental Characterizations	162
References	169
Chapter 4 Quantum Theory	170
4.1 Electrons	172
4.2 Dipole Radiation Reaction Force	173
4.3 The Time-Independent Schrödinger Equation	180
4.4 The Uncertainty Principle	184
4.5 The Time-Dependent Schrödinger Equation	186

4.6	Quantum Operator Properties	188
4.7	Orthogonality	189
4.8	Harmonic Oscillators	191
4.9	Electron Angular Momentum, Central Force Fields	194
4.10	The Coulomb Potential Source	196
4.11	Hydrogen Atom Eigenfunctions	199
4.12	Perturbation Analysis	202
4.13	Non-Ionizing Transitions	203
4.14	Absorption and Emission of Radiation	205
4.15	Electric Dipole Selection Rules for One Electron Atoms	208
4.16	Electron Spin	210
4.17	Many-Electron Problems	211
4.18	Measurement Discussion	214
	References	214
Chapter 5 Radiative Energy Exchanges		216
5.1	Blackbody Radiation, Rayleigh–Jeans Formula	216
5.2	Planck’s Radiation Law, Energy	218
5.3	Planck’s Radiation Law, Momentum	220
5.4	The Zero Point Field	225
5.5	The Photoelectric Effect	226
5.6	Power-Frequency Relationships	229
5.7	Length of the Wave Train and Radiation Q	233
5.8	The Extended Plane Wave Radiation Field	235
5.9	Gain and Radiation Pattern	239
5.10	Kinematic Values of the Radiation	241
	References	246
Chapter 6 Photons		247
6.1	Telefields and Far Fields	248
6.2	Evaluation of Sum S_{12} on the Axes	253
6.3	Evaluation of Sums S_{22} and S_{32} on the Polar Axes	257
6.4	Evaluation of Sum S_{32} in the Equatorial Plane	261
6.5	Evaluation of Sum S_{22} in the Equatorial Plane	263
6.6	Summary of the Axial Fields	265
6.7	Radiation Pattern at Infinite Radius	267
6.8	Multipolar Moments	270
6.9	Multipolar Photon-Field Stress and Shear	275
6.10	Self-Consistent Fields	285
6.11	Energy Exchanges	288
6.12	Self-Consistent Photon-Field Stress and Shear	291
6.13	Thermodynamic Equivalence	298
6.14	Discussion	303
	References	305

Chapter 7 Epilogue	306
7.1 Historical Background	306
7.2 Overview	311
7.3 The Radiation Scenario	316
References	320
Appendices	323
1 Introduction to Tensors	323
2 Tensor Operations	326
3 Tensor Symmetry	327
4 Differential Operations on Tensor Fields	328
5 Green's Function	330
6 The Potentials	335
7 Equivalent Sources	335
8 A Series Resonant Circuit	339
9 Q of Time Varying Systems	341
10 Bandwidth	344
11 Instantaneous and Complex Power in Radiation Fields	345
12 Conducting Boundary Conditions	347
13 Uniqueness	350
14 Spherical Shell Dipole	351
15 Gamma Functions	354
16 Azimuth Angle Trigonometric Functions	356
17 Zenith Angle Legendre Functions	359
18 Legendre Polynomials	363
19 Associated Legendre Functions	366
20 Orthogonality	367
21 Recursion Relationships	368
22 Integrals of Legendre Functions	375
23 Integrals of Fractional Order Legendre Functions	377
24 The First Solution Form	382
25 The Second Solution Form	384
26 Tables of Spherical Bessel, Neumann, and Hankel Functions	387
27 Spherical Bessel Function Sums	392
28 Static Scalar Potentials	395
29 Static Vector Potentials	400
30 Full Field Expansion	405
References	412
<i>Index</i>	413