1

1. SPACE- AND TIME-DEPENDENT LINEAR FIELDS

1.1 Formulation of Vector Field and Scalar Potential Problems, 1

1.1a The Scalar Acoustic Field, 2

530.141 FEL

General properties, 2 Scalar Green's function for unbounded space, 8

1.1b The Vector Electromagnetic Field, 9

General properties, 9 Dyadic Green's functions in free space (invariant evaluation), 14 Classical method, 15 Operator method, 15 Field of an electric dipole current, 16 Dyadic Green's functions for free space (transversely invariant)— Hertz potentials, 17 Dyadic Green's functions for bounded cylindrical regions, 23

1.1c The Plasma Field (One-component Fluid Model), 26

General properties, 26 Dyadic Green's functions for an unbounded, isotropic, electron plasma, 28 Reduced formulation of plasma field, 30

1.1d General Linear Field (Abstract Formulation), 31 Acoustic field, 31 Electromagnetic field, 32 One-Component plasma field, 32

1.2 Plane Wave Field Representations, 34

1.2a The Acoustic Field, 36 Steady-state power radiated by acoustic source, 40 1.2b The Electromagnetic Field, 41

Steady-state power radiated by electric and magnetic currents in free space, 43

- 1.2c The Plasma Field, 45 Steady-state power radiated by electric currents in unbounded plasma, 48
- 1.2d General Linear Field, 49

1.3 Guided Wave (Oscillatory) Representations in Time, 50

- 1.3a General Linear Field, 52
- 1.3b The Acoustic Field, 56 Oscillatory representation of acoustic Green's function, 57
- 1.3c The Electromagnetic Field, 58 Oscillatory representation of electromagnetic Green's function, 59
- 1.3d The Plasma Field, 60 Oscillatory representation of plasma Green's function, 62

1.4 Guided Wave Representations in Space, 63

- 1.4a General Linear Field, 66
- 1.4b The Acoustic Field, 68
- 1.4c The Electromagnetic Field, 71

1.5 Reduced Electromagnetic Field Equations, 75

1.5a Energy Density, Power Flow, and Group Velocity for the Electromagnetic Field, 76

Energy density and power flow, 78 Average energy transport (group velocity), 83

1.5b Boundary Conditions, Uniqueness, and Reciprocity Relations for the Electromagnetic Field, 86

Boundary conditions and uniqueness, 86 Reciprocity relations, 90

****xvi

1.5c Alternative Representations, 93

11

1.6 Ray-Optic Approximations of Integral Representations, 97

1.6a Oscillatory Integral Representations, 98

Homogeneous media, 98 Dispersion surfaces and space-time rays, 101 Weakly inhomogeneous media, 106

1.6b Guided Wave Integral Representations, 108

Homogeneous media (time-harmonic case), 108 z-stratified media (time-harmonic case), 111 z-stratified media (transient case), 114 Transients in non-dispersive configurations (closedform inversion of time-harmonic result), 116

1.6c Diffraction and Transition Phenomena, 117

Transient and signal propagation in a magnetoplasma (interaction between wavepackets), 119 Field behavior near a wavefront prior to formation of a wavepacket, 122

1.7 Rap-Optic Approximations for Differential Equations, 123

- 1.7a Rays and the Theory of Characteristics, 125
- 1.7b Scalar Time-Harmonic Fields, 128

Ray trajectories, 130 Phase functions, 132 Amplitude variation, 132

1.7c Vector Time-Harmonic Fields, 134

Isotropic media, 134 Anisotropic media, 137

1.7d The Geometrical Theory of Diffraction, 139

Ray reflection and refraction laws, 142 Isotropic media, 143 Anisotropic media, 144 Warm isotropic plasma, 145 Diffracted rays, 146 Example: Diffraction by a conducting half-plane on the interface between two isotropic dielectrics, 149

1.7e Transient Fields, 153

Solution of the dispersion equation, 155 Solution of the transport equation, 155 Reflection and refraction of spacetime rays, 156 Fields near the wavefront, 157

2. NETWORK FORMALISM FOR TIME-HARMONIC ELECTROMAGNETIC FIELDS IN UNIFORM AND SPHERICAL WAVEGUIDE REGIONS 183

2.1 Introduction, 183

2.2 Derivation of Transmission-Line Equations in Uniform Regions, 185

- 2.2a The Transverse Field Equations, 185
- 2.2b Modal Representations of the Fields and their Sources, 187
 E (TM) modes, 190 H (TE) modes, 190

2.3 Scalarization and Modal Representation of Dyadic Green's Functions in Uniform Regions, 190

- 2.3a Mode Functions, 191
- 2.3b Fields in Source-Free, Homogeneous Regions, 192
- 2.3c Green's Functions for Transmission-Line Equations, 193
- 2.3d Modal Representations of the Dyadic Green's Functions in a Piecewise Homogeneous Medium, 195
- 2.3e Modal Representations of the Dyadic Green's Functions in an Inhomogeneous Medium, 200

2.4 Solution of Uniform Transmission-Line Equations (Network Analysis), 202

- 2.4a Source-free Case, 202
- 2.4b Point Source on an Infinite Transmission line, 205
- 2.4c Excitation of General Transmission-Line Network by a Point Source, 207
- 2.4d Green's Functions for Transmission-Line Equations, 210
- 2.4e Resonance Properties of Terminated Transmission Lines, 215

2.5 Derivation of Transmission-Line Equations in Spherical Regions, 218

- 2.5a The Transverse Field Equations, 218
- 2.5b Modal Representation of the Fields and Their Sources, 219

2.6 Scalarization and Modal Representation of Dyadic Green's Functions in Spherical Regions, 222

- 2.6a Mode Functions, 222
- 2.6b Fields in Source-Free, Homogeneous Regions, 222
- 2.6c Modal Representations of the Dyadic Green's Functions, 224

2.7 Solution of Spherical Transmission-Line Equations (Network Analysis), 225

- 2.7a Source-Free and Source-Excited Transmission Lines, 225
- 2.7b Special Terminations, 229

Bilaterally matched region, 229 Homogeneous region, $0 < r < \infty$, 230 Semiinfinite homogeneous region, $0 < a \le r < \infty$, 230 Composite region, $0 < r < \infty$, 231

3. MODE FUNCTIONS IN CLOSED AND OPEN WAVEGUIDES 239

3.1 Introduction, 239

3.2 Classical Evaluation of Mode Functions, 241

- 3.2a General One-Dimensional Eigenvalue Problem, 241
- 3.2b Homogeneously Filled Rectangular Cross-Sections, 243

Finite rectangular region, 243Semiinfinite rectangularregion, 246Quarter-space region, 248Half-space region, 249Free-space region, 251Parallel-plate region, 252Transmission-line interpretationof one-dimensional eigenvalue problem, 253

3.2c Homogeneously Filled Cylindrical Cross-Sections, 254

Finite angular sector, 257 Open angular sector, 259 Circular waveguide, 263 Free space, 264

3.2d Inhomogeneously Filled Cross Sections, 265

Transverse field equations and modal representations, 265 Evaluation of vector-mode functions by transverse transmission

analysis, 268 Homogeneous cross-section, 269 Inhomogeneous cross-section, 271

3.3 Characteristic Green's Function (Resolvent) Procedure and Alternative Representations, 273

- 3.3a Relation Between Characteristic Green's Function and Eigenvalue Problems, 274
- 3.3b Construction of the Characteristic Green's Function, 278
- 3.3c Alternative Representations, 284

3.4 One-Dimensional Characteristic Green's Function and Eigenfunction Solutions, 289

3.4a Rectangular Cross Sections, 289

Bounded x domains, 289 H modes (along x), 289 E modes (along x), 294 Characteristic Green's function, 294 Delta function representation, 295 Semi-infinite x-domain, 296 Infinite x domain, 303

3.4b Angular Transmission Lines, 306

Cylindrical regions, 307 Spherical regions, 314 $0 \le \theta \le \pi$, 319 $0 < \theta < \theta_0 < \pi$, 320 $0 < \theta_1 \le \theta \le \theta_2 < \pi$, 321

34c. Radial Transmission Lines, 323

3.5 Approximate Methods for Solving the Non-Uniform Transmission-Line Equations, 328

- 3.5a Integral Equation Formulation, 329
- 3.5b The Comparison Equation, 336
- 3.5c Various comparison functions, 337

 $\alpha_0(x)$ has no zeros or poles (WKB solution), 337 $\alpha_0(x)$ has a simple zero, 338 $\alpha_0(x)$ has two neighboring simple zeros, 341 $\alpha(x, \Omega)$ has a simple pole, 343 $\alpha(x, \Omega)$ has neighboring simple pole and simple zero, 344

- 3.5d Error Bounds on the Approximate Solutions, 345
- 3.5e Corrections to the WKB Approximation, 347

3.6 Application to Various Inhomogeneity Profiles, 350

- 3.6a Reflection from a Continuous Transition, 350
- 3.6b The Epstein Solution for a Continuous Transition, 353
- 3.6c Dielectric Constant Profile with Simple Zero, 358

4. ASYMPTOTIC EVALUATION OF INTEGRALS

370

4.1 General Considerations, 370

- 4.1a Transformation to a Canonical Form, 370
 Infinite integrals, 370 Integrals with finite endpoints, 375
- 4.1b Saddle Points and Paths of Constant Level and Constant Phase, 377
 Saddle points, 377
 Paths of constant level and constant phase, 379

4.2 Isolated First-Order Saddle Points, 382

- 4.2a First-Order Approximation, 382 Analytical details, 383 Examples, 383
- 4.2b Complete Asymptotic Expansion, 384
- 4.2c First-Order, "Stationary Phase" Evaluation of Finite Integrals, 386 Example, 387
- 4.2d Steepest-Descent Evaluation of a Typical Diffraction Integral, 388
- 4.2e Integrands with Two Relevant Isolated Saddle Points: Asymptotic Expansion of the Airy Integral, 391

4.3 Isolated Saddle Points of Higher Order, 397

4.4 First-Order Saddle Point and Nearby Singularities, 399

4.4a Simple Pole Singularity, 399 Analytical details, 400

- 4.4b Multiple Pole Singularity, 406
- 4.4c Branch Point Singularity, 407
- 4.4d Uniform Asymptotic Evaluation of a Typical Diffraction Integral, 407

4.5 Nearby First-Order Saddle Points, 410

- 4.5a Two Saddle Points, 410 Analytical details, 413 Example: Asymptotic evaluation of Hankel function, 416
- 4.5b Three Saddle Points, 419

4.6 Saddle Points Near an Endpoint, 421

- 4.6a Single Saddle Point, 421
- 4.6b Two First-Order Saddle Points, 423
- 4.7 Multiple Integrals, 428
- 4.8 Integration Around a Branch Point, 429
- Appendix 4A. Higher-Order Derivatives of G(s) = f(z) dz/ds, 431

Appendix 4B. Properties of the Airy Functions, 432

5. FIELDS IN PLANE-STRATIFIED REGIONS

5.1 Introduction, 442

5.2 Field Representations in Regions with Piecewise Constant Properties, 444

5.2a Derivation of the Time-Harmonic Field From Scalar Potentials, 444

442

5.2b Modal Representations for Unbounded Cross Sections, 446 Point-source excitation, 448 Line-source excitation, 449

¥xii

- 5.2c Fields Excited by Impulsive Sources, 450
- 5.2d Fields Excited by Charges in Uniform Rectilinear Motion, 453

5.3 Integration Techniques, 455

ł

- 5.3a Analytical Properties of the Representation Integrals, 455
- 5.3b Definition of $\kappa(\xi) = \sqrt{k^2 \xi^2}$ in the Complex ξ -Plane, 459
- 5.3c The Transformation $\xi = k \sin w$, 462
- 5.3d Asymptotic Evaluation of a Typical Radiation Integral for the Incident and Reflected Fields, 464
- 5.3e General Properties of Pole and Branch-Point Wave Contributions, 470
- 5.3f Asymptotic Evaluation of a Typical Radiation Integral for the Transmitted Fields, 473

5.4 Sources in an Unbounded Dielectric, 476

5.4a Dipoles Oriented Along z, 477

Time-harmonic electric source current density: $\mathbf{J}(\mathbf{r}, t) = II \,\delta(\mathbf{r})e^{-i\omega t}\mathbf{z}_0$, 477 Discussion, 478 Normalization for plane wave incidence, 478 Modal procedure, 479 Alternative representations, 480 Pulsed electric source current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = \hat{p}\delta(\mathbf{r})(d/dt)\delta(t)\mathbf{z}_0$, 482 Magnetic dipole source, 483

5.4b Dipoles Oriented Transverse to z, 483

Time-harmonic electric source current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = Il \, \delta(\mathbf{r})e^{-i\omega t}\mathbf{y}_0$, 483 Discussion, 484 Time-harmonic magnetic source current density: $\hat{\mathbf{M}}(\mathbf{r}, t) = Vl \, \delta(\mathbf{r})e^{-i\omega t}\mathbf{y}_0$, 484 Pulsed electric or magnetic source currents, 484

5.4c Line Currents Oriented Transverse to z, 484

Time-harmonic electric source current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = I\delta(\hat{\mathbf{p}} - \hat{\mathbf{p}}')e^{-i\omega t}\mathbf{x}_0$, 484 Normalization for plane wave incidence, 486 Discussion, 486 Modal procedure, 487 Time-harmonic electric source current current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = I\delta(\hat{\mathbf{p}} - \hat{\mathbf{p}}')e^{-i\omega t}\mathbf{z}_0$, 489 Discussion, 489 Time-harmonic magnetic current density, 490 Pulsed source currents, 490

5.4d Line Currents Oriented along z, 491

Time-harmonic electric current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = I\delta(\mathbf{\rho} - \mathbf{\rho}') \cdot e^{i\mathbf{x}\mathbf{z}}e^{-i\omega t}\mathbf{z}_0, 491$ Discussion, 492

- 5.4e Point Charge in Uniform Straight Motion: $\hat{\mathbf{J}}(\mathbf{r}, t) = qv\delta(x vt)\delta(\hat{\mathbf{p}} \hat{\mathbf{p}}')\mathbf{x}_0$, 494 Discussion, 496 Modal representation, 498
- 5.4f Ring Currents, 499

Time-harmonic longitudinal electric source curreent density: $\hat{\mathbf{J}}(\mathbf{r}, t) = \mathbf{J}^0 \delta(\rho - \rho') \delta(z - z') e^{in\phi} e^{-i\omega t} \mathbf{z}_0$, 500 Discussion, 501 Modal representation (circular waveguide), 504 Timeharmonic azimuthal electric source current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = I\delta(\rho - \rho')\delta(z - z')e^{in\phi} e^{-i\omega t} \mathbf{\phi}_0$, 505 Time-harmonic magnetic current distributions, 506

5.5 Sources in the Presence of a Semi-Infinite Dielectric Medium, 506

- 5.5a Time-Harmonic Longitudinal Electric Current Element: $\hat{\mathbf{J}}(\mathbf{r}, t) = Il\delta(\mathbf{p})\delta(z z')e^{-i\omega t}\mathbf{z}_0$, 506 Discussion, 510 Analytical details, 514
- 5.5b Time-Harmonic Transverse Electric Current Element: $\hat{\mathbf{J}}(\mathbf{r}, t) = l \delta(\mathbf{\rho}) \cdot \delta(z z') e^{-i\omega t} \mathbf{x}_0$, 521
- 5.5c Time-Harmonic Magnetic Current Element, 523
- 5.5d Pulsed Longitudinal Electric Current Element: $\hat{\mathbf{J}}(\mathbf{r}, t) = \hat{\rho} \delta(\mathbf{p}) \delta(z z') \cdot (d/dt) \delta(t) \mathbf{z}_0$, 523 Analytical details, 525
- 5.5e Time-Harmonic Transverse Electric Line Current: $\hat{\mathbf{J}}(\mathbf{r}, t) = I\delta(\hat{\mathbf{p}} \hat{\mathbf{p}}') \cdot e^{-i\omega t} \mathbf{x}_0$, 527 Analytical details, 529
- 5.5f Time-Harmonic Transverse Line Distribution of Longitudinally Directed Electric Current Elements: $\hat{\mathbf{J}}(\mathbf{r}, t) = \mathbf{J}^0 \delta(\hat{\mathbf{p}} \hat{\mathbf{p}}') e^{-i\omega t} \mathbf{z}_0$, 530
- 5.5g Time-Harmonic Progressively Phased Transverse Electric Line Currents, 530

Transversely directed current elements: $\hat{\mathbf{J}}(\mathbf{r}, t) = I\delta(\hat{\mathbf{\rho}} - \hat{\mathbf{\rho}}') \cdot e^{i\alpha x} e^{-i\omega t} \mathbf{x}_0$, 530 Longitudinally directed current elements: $\hat{\mathbf{J}}(\mathbf{r}, t) = \mathbf{J}^0 \delta(\hat{\mathbf{\rho}} - \hat{\mathbf{\rho}}') e^{i\alpha x} e^{-i\omega t} \mathbf{z}_0$, 530

5.5h Time-Harmonic Ring Currents, 530

xxiv

- 5.5i Pulsed Transverse Electric Line Currents, 531 Analytical details, 532
- 5.5j Point Charge in Uniform Straight Motion Parallel to Interface, 532
- 5.5k Phenomena in Bounded Regions with Negative Real Dielectric Constant (Time-Harmonic Regime), 535

5.6 Time-Harmonic Sources in the Presence of a Dielectric Slab, 538

5.6a Longitudinal Electric Current Element: $\hat{\mathbf{J}}(\mathbf{r},t) = Il\delta(\mathbf{p})\delta(z-z')e^{-i\omega t}\mathbf{z}_0,$ 538

Discussion, 540 Analytical details, 543 Alternative representation (radial transmission formulation), 546 z-domain, 547 ϕ -domain, 547 Modifications for an ungrounded slab, 550

5.6b Other Source Configurations, 552

Transverse electric current element: $\hat{\mathbf{J}}(\mathbf{r}, t) = Il\delta(\mathbf{p})\delta(z - z') \cdot e^{-i\omega t}\mathbf{x}_0, 552$ Transverse electric line current: $\hat{\mathbf{J}}(\mathbf{r}, t) = I\delta(\mathbf{\hat{p}} - \mathbf{\hat{p}}')e^{-i\omega t}\mathbf{x}_0, 553$

5.7 Time-Harmonic Sources in the Presence of a Constant-Impedance Surface, 554

5.7a Longitudinal Electric Current Element: $\hat{\mathbf{J}}(\mathbf{r}, t) = Il\delta(\mathbf{p})\delta(z - z')e^{-i\omega t}\mathbf{z}_0$, 554

Discussion, 555 Analytical details, 556 An image formulation, 557

- 5.7b Transverse Magnetic Line Current: $\hat{\mathbf{M}}(\mathbf{r}, t) = V \delta(\hat{\mathbf{p}} \hat{\mathbf{p}}') e^{-i\omega t} z_0$, 559 Alternative representation, 561
- 5.7c Other Elementary Source Configurations, 562
- 5.7d Continuous Distribution of Transverse Magnetic Line Currents, 562 Excitation of surface waves by an aperture, 562 Radiation from a terminated reactive surface—comparison of

various approximations, 564

5.8 Sources in the Presence of Media with Continuous Planar Stratification-Arbitrary Profiles, 571

5.8a General Field Properties, 571

- xxvN
 - 5.8b Derivation of the Time-Harmonic Field from Scalar Potentials, 572
 - 5.8c Direct Ray-Optical Solution in a Slowly Varying Medium, 575

Ray trajectories, 575 Phase change along a ray, 577 Excitation by a transverse electric line current, 578 Excitation by a longitudinal electric current element, 581 Excitation by an incident plane wave, 581

5.8d Asymptotic Evaluation of a Typical Radiation Integral for a Medium with Monotonic Variation, 583

Excitation by an electric line current, 585 Asymptotic evaluation, 586 Evaluation near the caustic, 590

5.8e Propagation in Ducts-Guided Modes, 592

5.9 Sources in the Presence of Media with Continuous Planar Stratification-Special Profiles, 594

5.9a Inverse Square Profile, 595

Properties of the medium, 595 Solution for excitation by a longitudinal magnetic dipole or by a transverse electric line current, 597 Asymptotic evaluation, 599 Ray-optical interpretation, 601 The geometric-optical ray configuration, 606

5.9b Radiation in a Duct, 606

The guided mode spectrum, 606Radiation from a linesource, 608The guided-mode expansion, 610The geometric-optical series, 610

- 5.9c An Equivalence Relation for Fields in a Homogeneous and an Inverse Square Medium, 613
- 5.9d Continuous Transition (Epstein Profile), 619

6. FIELDS IN CYLINDRICAL AND SPHERICAL REGIONS 630

- 6.1 Distinctive Field Characteristics, 630
- 6.2 Green's Function Representations in Cylindrical Regions, 633
 - 6.2a Derivation of the Field From Scalar Potentials, 633

6.2b Angular Transmission Representation, 635

Time-harmonic line source, 636 Time-harmonic point source, 636 Impulsive line source, 637 Impulsive point source, 637 Plane wave incidence, 637

6.3 Wedge-Type Problems—Integration Techniques, 639

6.3a Time-Harmonic Line Source Excitation, 639

Solution in integral form, 639 Asymptotic approximation, 641 Transition effects (uniform asymptotic formulation), 643

- 6.3b Time-Harmonic Plane Wave and Point Source Excitations, 645 Solutions in integral form, 645 Asymptotic evaluation, 646
- 6.3c Pulsed Source Configurations, 647

6.4 Perfectly Absorbing Wedge, 650

- 6.4a Time-Harmonic Line Source Excitation, 651 Higher-order terms in the asymptotic expansion, 653
- 6.4b Impulsive Line Source Excitation, 654
- 6.4c Time-Harmonic Point Source Excitation, 656
- 6.4d Impulsive Point Source Excitation, 657
- 6.4e Time-Harmonic Plane Wave Excitation, 657
- 6.4f Impulsive Plane Wave Excitation, 659

6.5 Perfectly Conducting Wedge and Half Plane, 660

- 6.5a Angular Transmission Representation, 660
- 6.5b Radial Transmission Representation, 663
- 6.5c Time-Harmonic Line Source Excitation, 664
- 6.5d Impulsive Line Source Excitation, 666
- 6.5e Time-Harmonic Point Source Excitation, 667

∜xxviii

- 6.5f Impulsive Point Source Excitation, 668
- 6.5g Time-Harmonic Plane Wave Excitation, 669
- 6.5h Impulsive Plane Wave Excitation, 670
- 6.5i Special Case: The Half-Plane, 670

Time-harmonic line-source excitation, 671 Impulsive linesource excitation, 671 Time-harmonic point-source excitation, 672 Impulsive point-source excitation, 673 Timeharmonic plane-wave excitation, 673 Impulsive plane-wave excitation, 673

6.6 Wedge with Variable Impedance Walls, 674

6.6a One Perfectly Absorbing and One Variable-Impedance Wall, 675

Representation emphasizing quasi-optic properties, 675 Asymptotic evaluation, 677 Representation emphasizing guided-wave properties: surface wave, 681

6.6b Two Variable-Impedance Walls, 683

6.7 Diffraction by a Circular Cylinder, 685

6.7a Line-Source Excitation, 685

The residue series—physical interpretation, 691 Illuminated region—geometric-optical field, 693

6.7b Point-Source Excitation, 697

6.8 Fields in Spherical Regions, 698

- 6.8a Introduction, 698
- 6.8b Alternative Field Representations, 699 Free space, 699 The sphere, 701 The cone, 703
- 6.8c The Cone—Diffracted Field at High Frequencies, 705 Asymptotic expansion, 705 Approximation for small cone angles, 707

Appendix 6A. Asymptotic Formulas for $H_{\nu}^{(1)}(z)$ and $H_{\nu}^{(2)}(z)$, 710

6A.1 Large, Unequal Order and Argument, 710

6A.2 Large Argument, 712

6A.3 Large Order, 713

ź

ŗ

j

ĺ

6A.4 Large and Almost Equal Order and Argument, 715

6A.5 The Zeros of $H_{\nu}^{(1)}(z)$, $H_{\nu}^{\prime(1)}(z)$, and Related Results, 716

Appendix 6B. Miscellaneous Formulas Involving Cylinder Functions, 718

7. FIELDS IN UNIAXIALLY ANISOTROPIC REGIONS

740

7.1 Introduction, 740

7.2 Network Formulation of Field Problem, 745

- 7.2a Derivation of the Transmission Line Equations, 745
- 7.2b Formulation in Terms of Potential Functions, 749
- 7.2c The Dyadic Green's Functions, 750

General case, 750 Longitudinal sources, 752 Piecewise constant media, 752 Isotropic media, 753

7.3 Sources in Unbounded Media, 753

7.3a Dipoles Oriented along Optic Axis, 754

Time-harmonic electric source current density: $\mathbf{J}(\mathbf{r}, t) = Il\delta(\mathbf{r})e^{-i\omega t}\mathbf{z}_{0}, 754$ Modal procedure, 756 Time-harmonic magnetic source current density: $\mathbf{\hat{M}}(\mathbf{r}, t) = Vl\delta(\mathbf{r})e^{-i\omega t}\mathbf{z}_{0}, 762$

7.3b Dipoles Oriented Transverse to Optic Axis, 762

Time-harmonic electric source current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = Il\delta(\mathbf{r})e^{-i\omega t}\mathbf{x}_0$, 762 Time-harmonic magnetic source current density: $\hat{\mathbf{M}}(\mathbf{r}, t) = Vl\delta(\mathbf{r})e^{-i\omega t}\mathbf{x}_0$, 763

- 7.3c Linearly Phased Line Currents Oriented along Optic Axis, 763 Time-harmonic electric source current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = Ie^{i\alpha z} \delta(\mathbf{p})e^{-i\omega t} \mathbf{z}_0$, 763 Time-harmonic magnetic source current density: $\hat{\mathbf{M}}(\mathbf{r}, t) = Ve^{i\alpha z} \delta(\mathbf{p})e^{-i\omega t} \mathbf{z}_0$, 766
- 7.3d Point Charge in Uniform Straight Motion along Optic Axis, 766

7.3e Line Currents Oriented Perpendicular to Optic Axis, 767

Magnetic source current density: $\hat{\mathbf{M}}(\mathbf{r}, t) = V\delta(\hat{\mathbf{p}} - \hat{\mathbf{p}}')e^{-i\omega t}\mathbf{x}_0, 767$ Removal of the infinity in the radiated power, 769 Electric line source current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = I\delta(\hat{\mathbf{p}} - \hat{\mathbf{p}}')e^{-i\omega t}\mathbf{x}_0, 771$ Electric dipolar source current density: $\hat{\mathbf{J}}(\mathbf{r}, t) = A\delta(\hat{\mathbf{p}} - \hat{\mathbf{p}}')e^{-i\omega t}(\mathbf{y}_0 \cos \alpha + \mathbf{z}_0 \sin \alpha), 771$ Highly directive, distributed magnetic current source, 772

7.4 Diffraction by Structures Embedded in an Infinite Homogeneous Plasma, 776

- 7.4a Optic Axis Parallel to Axis of a Perfectly Conducting Cylindrical Obstacle, 776
- 7.4b Optic Axis Perpendicular to Axis of a Perfectly Conducting Cylindrical Obstacle, 776
 Formulation and reduction of the boundary value problem, 776
- 7.4c Half Space Bounded by a Perfect Conductor, 779
- 7.4d Half Space Bounded by a Reactive Surface, 781
- 7.4e Wedge and Half Plane, 783

7.5 Radiation from a Homogeneous Plasma Half Space, 787

- 7.5a Formulation of the Problem (Line-Source Excitation), 788
- 7.5b Reflection and Transmission of Plane Waves, and the Radiation Condition, 789
- 7.5c Modal Representation of the Solution, 793
- 7.5d Asymptotic Evaluation in the Plasma Half Space, 794

The geometric-optical field, 796 The lateral waves, 799 Fields in the vicinity of the angle of total reflection, 802

7.5e Asymptotic Evaluation in the Vacuum Half Space, 806

Ray interpretation of the saddle point condition—caustic and cusp, 806 Asymptotic field evaluation, 808

7.5f Radiation from a Transverse Electric Dipole, 813

8. FIELDS IN ANISOTROPIC REGIONS

8.1 Introduction, 821

8.2 Guided Wave Representation in Anisotropic Media (Reduced Formulation), 823

- 8.2a Formulation for Arbitrary Media, 823
- 8.2b Lossless Regions, 826
- 8.2c Lossy (Symmetric) Regions, 827
- 8.2d Transverse anisotropy (Reflection Symmetry), 827
- 8.2e Isotropic Regions, 828
- 8.2f Regions with E- and H-Mode Decompositions, 829
- 8.2g Modal Representations for the Reduced Electromagnetic Field, 831
- 8.2h Non-Conventional Transmission Line Descriptions, 832

8.3 Guided Waves in a Cold Magnetoplasma (Guide Axis Parallel to Gyrotropic Axis), 832

- 8.3a Evaluation of the Mode Functions, 837
- 8.3b Wavenumber Surfaces, 843
- 8.3c Green's Functions for Unbounded Regions, 846

Modal representation, 846 Asymptotic evaluation of far fields, 849 Transition region: coalescence of two saddle points, 853 Transition region: saddle point moves to infinity, 854

8.3d Green's Functions for Plane-Stratified Regions, 855

Representation in terms of ordinary and extraordinary modes, 855 Asymptotic evaluation of the fields, 857

8.4 Guided Waves in a Cold Magnetoplasma (Guide Axis Perpendicular to Gyrotropic Axis), 860

8.4a Eigenfunctions and Eigenvalues for b_0 Perpendicular to z_0 , 860

8.4b Two-Dimensional Boundary Value Problems in Gyrotropic Media, 862
8.4c Radiation from a Magnetic Line Source in the Presence of a Perfectly Conducting Plane, 864 Unidirectional surface wave, 866 The far field, 868
8.4d Diffraction by a Half-Plane, 869

SUBJECT INDEX

AUTHOR INDEX

885

877

X xxxii

Contents