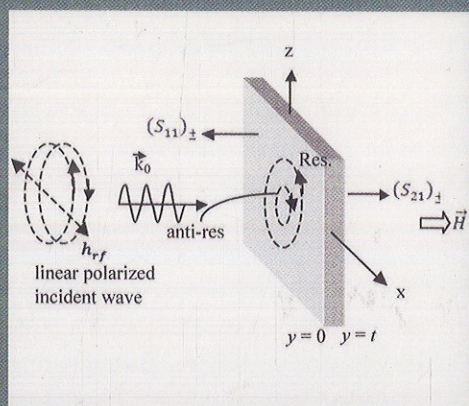
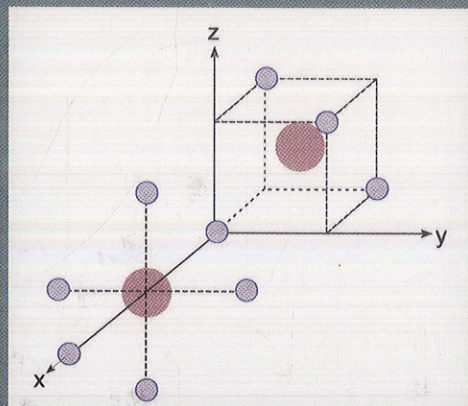
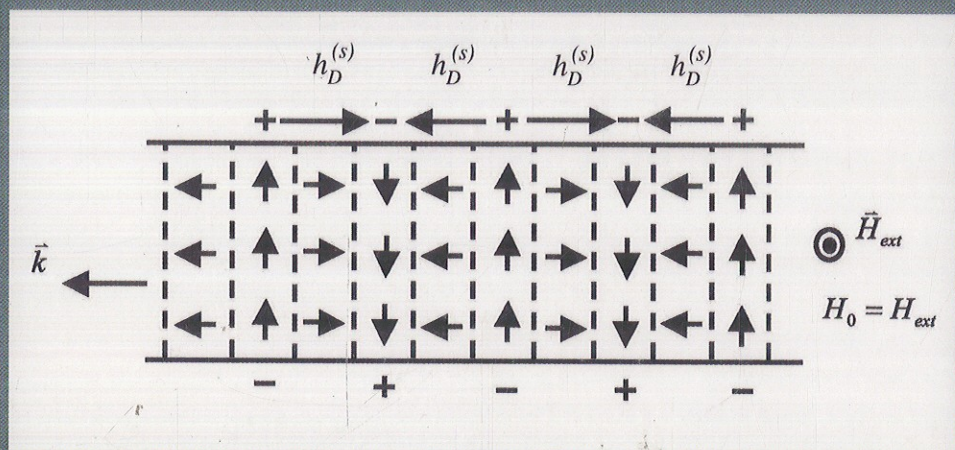


Magnetics, Dielectrics, and Wave Propagation with MATLAB[®] Codes



Carmine Vittoria



CRC Press
Taylor & Francis Group

Contents

Preface.....	xi
Acknowledgments	xv
Author.....	xvii
1. Review of Maxwell Equations and Units	1
Maxwell Equations in MKS System of Units.....	1
Major and Minor Magnetic Hysteresis Loops	2
Tensor and Dyadic Quantities	6
Maxwell Equations in Gaussian System of Units	10
External, Surface, and Internal Electromagnetic Fields	12
Problems	15
Appendix 1.A: Conversion of Units.....	16
References.....	18
Solutions	19
2. Classical Principles of Magnetism	29
Historical Background.....	29
First Observation of Magnetic Resonance	29
Definition of Magnetic Dipole Moment.....	30
Magnetostatics of Magnetized Bodies.....	35
Electrostatics of Electric Dipole Moment.....	41
Relationship between B and H Fields	43
General Definition of Magnetic Moment.....	46
Classical Motion of the Magnetic Moment	48
Problems	51
Appendix 2.A.....	52
References.....	53
Solutions	53
3. Introduction to Magnetism	61
Energy Levels and Wave Functions of Atoms	63
Spin Motion.....	67
Intra-Exchange Interactions	70
Heisenberg Representation of Exchange Coupling.....	74
Multiplet States.....	75
Hund Rules	78
Spin-Orbit Interaction	79

Lande g_J -Factor	81
Effects of Magnetic Field on a Free Atom	83
Crystal Field Effects on Magnetic Ions	88
Superexchange Coupling between Magnetic Ions	92
Double Superexchange Coupling	101
Ferromagnetism in Magnetic Metals.....	103
Problems	107
Appendix 3.A: Matrix Representation of Quantum Mechanics.....	109
References.....	112
Solutions	113
 4. Free Magnetic Energy	 121
Thermodynamics of Noninteracting Spins: Paramagnets.....	121
Ferromagnetic Interaction in Solids.....	124
Ferrimagnetic Ordering.....	129
Spinwave Energy	131
Effects of Thermal Spinwave Excitations	135
Free Magnetic Energy.....	136
Single Ion Model for Magnetic Anisotropy	137
Pair Model.....	140
Demagnetizing Field Contribution to Free Energy.....	141
Numerical Examples.....	143
Cubic Magnetic Anisotropy Energy.....	148
Uniaxial Magnetic Anisotropy Energy	150
Problems	151
References.....	152
Solutions	153
 5. Phenomenological Theory	 167
Smit and Beljers Formulation.....	167
Examples of Ferromagnetic Resonance	170
Simple Model for Hysteresis	181
General Formulation.....	187
Connection between Free Energy and Internal Fields.....	188
Static Field Equations	189
Dynamic Equations of Motion	190
Microwave Permeability	196
Normal Modes.....	199
Magnetic Relaxation	203
Free Energy of Multi-Domains.....	209
Problems	212
References.....	213
Solutions	213

6. Electrical Properties of Magneto-Dielectric Films	229
Basic Difference between Electric and Magnetic Dipole Moments	229
Electric Dipole Orientation in a Field.....	230
Equation of Motion of Electrical Dipole Moment in a Solid	231
Free Energy of Electrical Materials.....	233
Magneto-Elastic Coupling.....	235
Microwave Properties of Perfect Conductors	238
Principles of Superconductivity: Type I.....	239
Magnetic Susceptibility of Superconductors: Type I	245
London's Penetration Depth.....	246
Type-II Superconductors.....	248
Microwave Surface Impedance	251
Conduction through a Non-Superconducting Constriction	252
Isotopic Spin Representation of Feynman Equations	255
Problems	260
Appendix 6.A.....	262
References	263
Solutions	264
7. Kramers-Kronig Equations	271
Problems	276
References.....	277
Solutions	277
8. Electromagnetic Wave Propagation in Anisotropic	
Magneto-Dielectric Media	281
Spinwave Dispersions for Semi-Infinite Medium	286
Spinwave Dispersion at High k -Values	287
The $k = 0$ Spinwave Limit	288
Sphere	288
Thin Films.....	289
Needle	291
Surface or Localized Spinwave Excitations.....	292
Pure Electromagnetic Modes of Propagation:	
Semi-Infinite Medium.....	295
Coupling of the Equation of Motion and Maxwell's Equations	296
Normal Modes of Spinwave Excitations	308
Magnetostatic Wave Excitations	313
$\underline{M}$ Perpendicular to Film Plane	314
$\underline{H}$ in the Film Plane.....	321
Ferrite Bounded by Parallel Plates	325
Problems	327
Appendix 8.A.....	328
Perpendicular Case	332
In Plane Case	333

References	334
Solutions	335
9. Spin Surface Boundary Conditions	339
A Quantitative Estimate of Magnetic Surface Energy	341
Another Source of Surface Magnetic Energy	343
Static Field Boundary Conditions	344
Dynamic Field Boundary Conditions	346
Applications of Boundary Conditions	348
$\vec{H} \perp$ to the Film Plane.....	348
$\vec{H} //$ to the Film Plane	352
Electromagnetic Spin Boundary Conditions	353
Problems	357
Appendix 9.A.....	358
Perpendicular Case	358
In Plane Case	365
References	378
Solutions	378
10. Matrix Representation of Wave Propagation	387
Matrix Representation of Wave Propagation in Single Layers	387
($//$) Case	388
($\perp$) Case	392
The Incident Field	393
Ferromagnetic Resonance in Composite Structures:	
No Exchange Coupling	397
Ferromagnetic Resonance in Composite Structures:	
Exchange Coupling	401
($\perp$) Case	402
Boundary Conditions.....	405
($//$) Case	409
Boundary Conditions ($//$ FMR).....	410
Problems	413
Appendix 10.A.....	414
Calculation of Transmission Line Parameters	
from $[A]$ Matrix	414
Microwave Response to Microwave Cavity Loaded	
with Magnetic Thin Film	427
References	432
Solutions	433
Index	441