## CONTENTS

Preface ................................................... v

Chapter 1
INTRODUCTORY REMARKS ................................. 1

Chapter 2
MAGNETIC SHIELDING .......................................... 5

2.1 Fundamental Equations and Boundary Conditions ................. 5

2.2 Magnetic Shielding by Spherical Shells ......................... 6

2.2.1 Single Shell ........................................... 6

2.2.1.1 Shielding Ratio for an External Magnetic Field ........ 6

2.2.1.2 Magnetic Lines of Force ............................ 10

2.2.1.3 Thick and Thin Shells ............................... 15

2.2.1.4 A Magnetic Dipole in a Shell—An External Problem .... 15

2.2.1.5 Magnetic Field Arising from a Shell Having a Rema-

nant Magnetization ............................................ 19

2.2.2 Multiple Shells .......................................... 28

2.2.2.1 Theory for Multiple Shells ......................... 29

2.2.2.2 How Efficient is a System of Multiple Shells? ........ 32

2.2.2.3 Magnetic Lines of Force and Their Density ............ 35

2.2.2.4 Optimal Model of Multiple Shells for Shielding ....... 36

2.3 Magnetic Shielding by Cylindrical Shells ..................... 38

2.3.1 Cylindrical Shell of Infinite Length .................... 40

2.3.2 Cylindrical Shell of Finite Length ..................... 44

2.3.2.1 External Magnetic Field Parallel to the Cylinder Axis . 45

2.3.2.2 External Magnetic Field Perpendicular to the Cylinder

Axis ................................................................. 63

2.3.2.3 Summary of Magnetic Shielding by Cylindrical Shells of

Finite Length .................................................. 86

2.4 Magnetic Shielding by Rectangular Shells of Infinite

Length ......................................................... 88

2.4.1 Models and Magnetic Lines of Force ........................ 88
2.4.1.1 Relaxation ........................................ 89
2.4.1.2 Boundary Conditions .......................... 89
2.4.2 Solid and Hollow Prisms ......................... 94
2.4.3 Incomplete Square Shell ......................... 102

Chapter 3

ELECTROMAGNETIC SHIELDING ......................... 107

3.1 Fundamental Equations ............................ 108
3.2 Plane Slab ........................................ 110
3.2.1 Line of Magnetic Dipoles over a Uniform Slab . 117
3.3 Spherical Shell ................................... 120
3.3.1 Conductors with Spherical Symmetry .......... 120
3.3.2 Electromagnetic Induction by a Magnetic Field Arising from Outside a Spherical Shell .......... 121
3.3.3 Shielding Effect to an External Field .......... 124
3.3.4 Electromagnetic Induction by a Magnetic Field Arising from Inside a Spherical Shell ............ 127
3.3.5 Shielding Effect to an Internal Field .......... 130
3.4 Cylindrical Shell of Infinite Length ............ 130
3.4.1 Electromagnetic Induction by a Magnetic Field Arising from Outside a Cylindrical Shell .......... 131
3.4.2 Shielding Effect to an External Field .......... 134
3.5 Square and Octagonal Shells of Infinite Length . 137
3.5.1 Differential Equations and Boundary Conditions .................................................. 137
3.5.2 Application of the Relaxation Method .......... 139
3.5.3 Square Prism and Shell .......................... 139
3.5.3.1 Square Prism .................................. 139
3.5.3.2 Square Shell .................................. 142
3.5.3.3 Square Shell in a Magnetic Field in a Direction which Makes an Angle of 45° with the Shell Wall .... 144
3.5.3.4 Octagonal Shell ................................ 146
3.6 Thin Sheet or Shell .................................. 149
3.6.1 Theory of Electromagnetic Induction in a Thin Sheet .................................................. 149
3.6.2 Plane Sheet ....................................... 154
3.6.3 Cylindrical Sheet ................................. 156
3.6.4 Spherical Sheet ................................... 158
3.6.5 Hemispherical Sheet ............................. 161
3.6.6 Square Sheet ..................................... 162
3.7 Shielding by Two Concentric Spherical Shells, One Electrically Conducting, the Other Magnetically Permeable .................................................. 164
3.7.1 Model 1 ........................................... 167