CONTENTS

PAGE

PREFACE vii

Chapter I

ELASTIC WAVES IN A ONE-DIMENSIONAL LATTICE OF POINT MASSES: EARLY WORK AND INTRODUCTION

SECTION

1. Historical Background; Eighteenth Century 1
2. Historical Background; Nineteenth Century. Cauchy, Baden-Powell, and Kelvin 3
3. Later Work on Models Similar to That Treated in Sec. 2 11

Chapter II

PROPAGATION OF WAVES ALONG ONE-DIMENSIONAL LATTICES. GENERAL RESULTS AND QUALITATIVE DISCUSSION

4. General Remarks 17
5. A Lattice of Free Particles 19
6. Longitudinal Vibration in a Row of Equidistant Coupled Oscillators 21
7. Longitudinal Vibrations in a Row of Diatomic Molecules 22

Chapter III

MATHEMATICAL TREATMENT OF A ONE-DIMENSIONAL LATTICE OF IDENTICAL PARTICLES

8. Equation of Motion of a One-dimensional Lattice of Identical Particles 26
9. Rigorous Discussion for the Case of Interactions between Nearest Neighbors Only 31
10. Discussion of the Distance of Interaction 33
11. The Low-pass Electric Filter 37
12. Analogies between Electrical and Mechanical Systems 40

Chapter IV

Mathematical Treatment of More Complicated One-dimensional Lattices

Section		Page
13.	Equations of Motion for the One-dimensional NaCl Lattice	44
14.	Electrical Analogue of the One-dimensional Diatomic Lattice	47
15.	Discussion of the One-dimensional NaCl Lattice	50
16.	Transition from a Diatomic to a Monatomic Lattice	57
17.	The One-dimensional Lattice of Polyatomic Molecules	65

Chapter V

Energy Velocity, Energy Flow, and Characteristic Impedance

18.	General Discussion; Phase Velocity	69
19.	A Theorem from the Theory of Complex Variables	70
20.	Energy Density, Energy Flow, and Energy Velocity	72
21.	Group Velocity and Propagation of a Signal	74
22.	Preliminary Definition of Characteristic Impedance	80
23.	Junction of Two Lattices	85
24.	General Definition of Characteristic Impedance	88

Chapter VI

Two-dimensional Lattices

25.	Direct and Reciprocal Lattices in Two Dimensions	94
26.	Doubly and Triply Periodic Functions	99
27.	Zones in a Two-dimensional Lattice	102
28.	Propagation of Waves in a Continuous Two-dimensional Medium with a Periodic Perturbation	107
29.	The Exceptional Waves of Case 2 and Bragg Reflection	115
30.	Transition Near the Discontinuity	118
31.	Examples and Discussion of Zones in Two Dimensions	121

Chapter VII

Three-dimensional Lattice

32.	Direct and Reciprocal Lattices in Three Dimensions	131
33.	Zones in Three Dimensions and Bragg Reflection; Ewald's Construction	136

SECTION PAGE
34. General Results for a Wave Propagating in a Three-dimensional Periodic Medium 139
35. Waves in a Homogeneous Isotropic Medium with a Small Periodic Perturbation 143
36. General Remarks on Waves in a Discontinuous Lattice 147
37. Some Examples of Zones in Three Dimensions 148
38. Zones in the Direct Lattice; Principle of the Wigner-Seitz Method 155
39. Frequency Distribution for Waves in an Actual Crystal 157
40. The Energy of a Solid; the Characteristic Temperatures 164
41. Thermal Expansion and Entropy of a Solid Body 167

Chapter VIII

MATHIEU'S EQUATION AND RELATED PROBLEMS

42. Mathieu's Equation 172
43. Mathieu Functions: General Discussion 175
44. Hill's Equation with a Rectangular Curve 180
45. The Self-excited Oscillator 186
46. Free Electrons in Metals 190

Chapter IX

MATRICES AND THE PROPAGATION OF WAVES ALONG AN ELECTRIC LINE

47. General Remarks 193
48. Expressions for Energy 197
49. Definition of a Four-terminal and Equation for Its Circuit 200
50. Matrix Notation for a Four-terminal 201
51. Combination of Two Four-terminals; Multiplication of Matrices 203
52. Inverse and Reversed Four-terminals and Transformations 204
53. Four-terminal Matrices and the Group C_2 206
54. Surge, Iterative, or Characteristic Impedance of a Four-terminal 209
55. Propagation along a Line of Four-terminals 211
56. Application of the Theory to a Reversible Four-terminal 214
57. Passing Bands and Attenuation in a Line of Four-terminals 216

SECTION PAGE
58. Reflected Waves in a Line Terminated by an Impedance ζ_0 217
59. A Continuous Line Loaded with Two-terminals 218
60. A Continuous Line Loaded with Four-terminals 224

Chapter X

CONTINUOUS ELECTRIC LINES

61. Transition from a Line of Four-terminals to a Continuous Line 227
62. Examples of Four-terminal Representation of Continuous Lines 229
63. Application of Hill's Equation to a Continuous Line 232
64. Normalization of the Matrix (ϵ_{ij}) and the Pauli Matrices 234
65. Three-phase and Polyphase Lines 236

APPENDIX 241

INDEX 249