Contents

1 Introduction 9

2 Preliminaries 17
- 2.1 Tensor analysis . . . 17
- 2.2 Geometry of curves and surfaces . . . 24
- 2.3 Dynamic theory of elasticity . . . 30
- 2.4 Dynamic theory of piezoelectricity . . . 37
- 2.5 Variational-asymptotic method . . . 45

I Low-frequency vibrations 57

3 Elastic shells 59
- 3.1 Two-dimensional equations . . . 59
- 3.2 Asymptotic analysis . . . 68
- 3.3 Dispersion of waves in plates . . . 78
- 3.4 Frequency spectra of circular plates . . . 89
- 3.5 Dispersion of waves in cylindrical shells . . . 96
- 3.6 Frequency spectra of cylindrical shells . . . 109
- 3.7 Frequency spectra of spherical shells . . . 118

4 Elastic rods 123
- 4.1 One-dimensional equations . . . 123
- 4.2 Asymptotic analysis . . . 130
- 4.3 Cross section problems . . . 140
- 4.4 Dispersion of waves . . . 147
- 4.5 Frequency spectra . . . 155

5 Piezoelectric shells 163
- 5.1 Two-dimensional equations . . . 163
- 5.2 Asymptotic analysis . . . 172

5.3 Error estimation and comparison 183
5.4 Frequency spectra of circular plates 193
5.5 Frequency spectra of cylindrical shells 200

6 Piezoelectric rods **209**
6.1 One-dimensional equations 209
6.2 Asymptotic analysis 215
6.3 Cross section problems 224
6.4 Frequency spectra 234
6.5 Longitudinal impact 240

II High-frequency vibrations **249**

7 Elastic shells **251**
7.1 Two-dimensional equations 251
7.2 Long-wave asymptotic analysis 257
7.3 Short-wave extrapolation 267
7.4 Dispersion of waves in plates 275
7.5 Frequency spectra of plates 285
7.6 Dispersion of waves in cylindrical shells 296
7.7 Frequency spectra of cylindrical shells 305

8 Elastic rods **311**
8.1 One-dimensional equations 311
8.2 Long-wave asymptotic analysis 316
8.3 Short-wave extrapolation 322
8.4 Cross section problems 329
8.5 Dispersion of waves 336
8.6 Frequency spectra 340

9 Piezoelectric shells **349**
9.1 Two-dimensional equations 349
9.2 Long-wave asymptotic analysis 351
9.3 Short-wave extrapolation 360
9.4 Frequency spectra of circular plates 369
9.5 Frequency spectra of cylindrical shells 374

10 Piezoelectric rods **381**
10.1 One-dimensional equations 381
10.2 Long-wave asymptotic analysis 383
10.3 Short-wave extrapolation 390

10.4 Cross section problems 395
10.5 Frequency spectra 400

A Material constants **405**
A.1 Elastic isotropic materials 405
A.2 Piezoelectric crystals 406
A.3 Piezoceramic materials 408

B List of notations **409**

Bibliography **413**

Index **419**

http://www.springer.com/978-3-540-64516-0

Vibrations of Shells and Rods
Le, K.C.
1999, IV, 423 p., Hardcover
ISBN: 978-3-540-64516-0