

Contents

Contributors	xi
Preface	xiii
Contents of Volume 1	xv
Contents of Volume 2	xvii
Summary	xix
I On Modeling the Dynamics of Composite Materials	
A. Bedford, D. S. Drumheller, and H. J. Sutherland	1
1. Introduction	1
2. Theoretical and Experimental Background	3
2.1 Steady-state Waves	3
2.2 Transient Waves	10
3. Structured Continuum Theory	16
3.1 Coordinate Systems	16
3.2 Displacement Expansions	17
3.3 Interface Continuity Conditions	18
3.4 Equations of Motion	20
3.5 Boundary Conditions	22
4. Results of the Theory	28
4.1 Dispersion Results	29
4.2 Modal Results	34
4.3 Transient Results	40
5. Experimental Methods	41
5.1 Ultrasonic Waves	41
5.2 Low-amplitude Transient Waves	45
5.3 High-amplitude Transient Waves	46
6. Potential Future Developments	49
7. References	50

vi Contents

II The Analysis of Elastodynamic Crack Tip Stress Fields	
L. B. Freund	55
1. Introduction	55
2. Equations of Linear Elastodynamics	57
2.1 Equations of Motion	57
2.2 Work and Energy Relations	59
2.3 The Laplace Transform	60
3. Crack Tip Stress Fields	60
4. Energy Considerations	64
4.1 Conservation Laws	64
4.2 A Path-independent Integral for Dynamic Loading	66
4.3 Energy Flux into a Moving Crack Tip	69
4.4 Uniqueness of Solution for Running Cracks	70
5. Stationary Crack under Dynamic Loading	71
5.1 The Weight Function Method	72
5.2 An Example	75
6. Crack Extension at Nonuniform Rates	77
6.1 The Stress Intensity Factor	77
6.2 The Crack Tip Equation of Motion	81
7. Continuous Distribution of Moving Dislocations	82
7.1 The Superposition Method	82
7.2 An Example	84
8. Discussion	89
9. References	90
III Random Vibration of Periodic and Almost Periodic Structures	
Y. K. Lin	93
1. Introduction	93
2. Discrete Periodic Systems	97
3. Continuous Periodic System—Point Loading	104
4. Continuous Periodic System—Convected Loading	115
5. Concluding Remarks	119
6. References	121
Appendix A	122
IV Integral Representations and the Oseen Flow Problem	
W. E. Olmstead and A. K. Gautesen	125
1. Introduction	125
2. Integral Formulation	127
2.1 The Fundamental Solution	128

2.2	Integral Representation of the Oseen Solution	129
2.3	Integral Equations for the Stress Components	130
3.	Structure of the Problem	130
3.1	The Inhomogeneous Oseen Problem	131
3.2	Force Relationships and Drag Invariance	132
3.3	Asymptotic Behavior at Infinity	133
3.4	Uniqueness of the Oseen Solution	134
3.5	Existence of the Oseen Solution	136
3.6	The Navier–Stokes Solution	137
3.7	The Oseen Problem in Two Dimensions	138
	A. Integral Formulation	139
	B. Symmetric Flows	140
	C. Auxiliary Functions and Modes	141
4.	Results on Integral Equations	144
4.1	Equations on a Semi-infinite Interval	145
4.2	Equations on a Finite Interval	146
4.3	Equations on Two Disjoint Intervals	148
4.4	Equations on Circular Arcs	150
4.5	Singularities and Positivity of the Solutions	150
4.6	Variational Problems	151
5.	Solutions of the Oseen Problem for Planar Flows	153
5.1	Semi-infinite Plate Problems	153
	A. Symmetric Flow Past the Plate	155
	B. The Homogeneous Solution and Nonuniqueness	155
	C. Plate and Horizontal Force Singularity	158
	D. Plate and Vertical Force Singularity	160
	E. Symmetric Flow with Vertical Oscillations	162
5.2	Green's Tensor for the Semi-infinite Plate	163
5.3	Finite Plate Problems	166
	A. Single Inclined Plate	168
	B. Two Parallel Plates	170
	C. Two Coplanar Plates	170
	D. Positivity and Singularities	172
5.4	Circular Arc Problems	173
5.5	Application of Variational Methods	175
5.6	Injection–Suction Problems	179
	A. Semi-infinite Plate	180
	B. Finite Plate	182
5.7	Free Surface Problems	184
6.	Concluding Remarks	186
7.	References	187

viii Contents

V On Nonlinear Gyroscopic Systems

P. R. Sethna and M. Balu Balachandra	191
1. Introduction	191
2. Derivation of Equations of Motion	194
2.1 Equations of Motion for a Holonomic Dynamical System with Imposed Motions	194
2.2 Equations of Motion for a Holonomic Dynamical System with Cyclic Coordinates	196
3. Weakly Nonlinear Systems and Linearization	198
4. Weakly Nonlinear Systems—Hamiltonian Formulation	210
4.1 An Example	217
5. High Spin Gyroscopic Systems	221
5.1 Initial Motions	232
5.2 Analysis in the Case When Initial Velocities are Small	236
5.3 Example: Single Axis Stable Platform	237
6. References	241

VI Application of the WKB Method in Solid Mechanics

Charles R. Steele	243
1. Introduction	243
2. First Approximation	247
2.1 Green–Liouville Transformation	249
2.2 Boundary-layer Problems	250
2.3 Eigenvalue Problems	250
2.4 Steady-state Wave Propagation	253
2.5 Transient Pulse Propagation	254
2.6 Conservative Systems	257
3. Successive Corrections	260
3.1 Formal Asymptotic Expansion	261
3.2 Convergent Expansion	263
3.3 Corrections to Eigenvalues	265
3.4 Reflections in Pulse Propagation	267
4. Formal Expansions for Transition Points	270
4.1 Coalescence of Two Roots at Zero	274
4.2 More General Coalescence of Two Roots	277
4.3 Coalescence of Four Roots at Zero	278
5. Vibration with Transition Point	283
5.1 Torsion of Elastically Constrained Rod	283
5.2 Taut Beam on Elastic Foundation	285

	Contents	ix
5.3 Beam on Elastic Foundation		288
5.4 Shell of Revolution		289
6. References		293
Author Index		297
Subject Index		301