

1 Mechanical Systems with One Degree of Freedom 1

1.1 A Simple Mass–Spring System 1

1.2 Free Vibrations 5

1.3 Transient Vibrations 11

1.4 Forced Harmonic Vibrations 19

1.5 Fourier Series. 23

1.6 Complex Notation 25

Problems 29

2 Frequency Domain 31

2.1 Introduction 31

2.2 Frequency Response 33

2.3 Correlation Functions 36

2.4 Spectral Density 38

2.5 Examples of Spectral Density. 40

2.6 Coherence 44

2.7 Time Averages of Power and Energy 45

2.8 Frequency Response and Point Mobility Functions 51

2.9 Loss Factor 57

2.10 Response of a 1-DOF System, A Summary 61

Problems 64

3 Waves in Solids 67

3.1 Stresses and Strains 67

3.2 Losses in Solids 75

3.3 Transverse Waves. 79

3.4 Longitudinal Waves 82

3.5 Torsional Waves 85

3.6 Waves on a String 87

3.7 Bending or Flexural Waves-Beams 89

3.8 Waves on Strings and Beams—A Comparison 96

3.9	Flexural Waves-Plates	99
3.10	Orthotropic Plates	105
3.11	Energy Flow	107
	Problems	109
4	Interaction Between Longitudinal and Transverse Waves	111
4.1	Generalized Wave Equation	111
4.2	Intensity	115
4.3	Coupling Between Longitudinal and Transverse Waves	116
4.4	Bending of Thick Beams/Plates	121
4.5	Quasi-Longitudinal Waves in Thick Plates	134
4.6	Rayleigh Waves	137
4.7	Sandwich Plates-General	138
4.8	Bending of Sandwich Plates	140
4.9	Equations Governing Bending of Sandwich Plates	141
4.10	Wavenumbers of Sandwich Plates	144
4.11	Bending Stiffness of Sandwich Plates	145
4.12	Bending of I-Beams	146
	Problems	150
5	Wave Attenuation Due to Losses and Transmission	
	Across Junctions	153
5.1	Excitation and Propagation of L-waves	153
5.2	Excitation and Propagation of F-Waves	158
5.3	Point Excited Infinite Plate	162
5.4	Spatial Fourier Transforms	166
5.5	Added Damping	173
5.6	Losses in Sandwich Plates	179
5.7	Coupling Between Flexural and Inplane Waves	182
5.8	Transmission of F-Waves Across Junctions, Diffuse Incidence	186
5.9	Transmission of F-Waves Across Junctions, Normal Incidence	193
5.10	Attenuation Due to Change of Cross Section	195
5.11	Some Other Methods to Increase Attenuation	198
5.12	Velocity Level Differences and Transmission Losses	199
5.13	Measurements on Junctions Between Beams	203
	Problems	209
6	Longitudinal Vibrations of Finite Beams	213
6.1	Free Longitudinal Vibrations in Finite Beams	213
6.2	Forced Longitudinal Vibrations in Finite Beams	223
6.3	The Mode Summation Technique	228
6.4	Kinetic Energy of Vibrating Beam	232

6.5	Mobilities	237
6.6	Mass Mounted on a Rod	240
6.7	Transfer Matrices	244
	Problems	248
7	Flexural Vibrations of Finite Beams	251
7.1	Free Flexural Vibrations of Beams	251
7.2	Orthogonality and Norm of Eigenfunctions	260
7.3	Forced Excitation of F-Waves	264
7.4	Mode Summation and Modal Parameters	268
7.5	Point Mobility and Power	274
7.6	Transfer Matrices for Bending of Beams	278
7.7	Infinite Periodic Structures	282
7.8	Forced Vibration of Periodic Structures	287
7.9	Finite Composite Beam	292
	Problems	297
8	Flexural Vibrations of Finite Plates	301
8.1	Free Vibrations of Simply Supported Plates	301
8.2	Forced Response of a Simply Supported Plate	308
8.3	Forced Excitation of a Rectangular Plate with Two Opposite Sides Simply Supported	313
8.4	Power and Energy	318
8.5	Mobility of Plates	322
8.6	The Rayleigh–Ritz Method	326
8.7	Application of the Rayleigh–Ritz Method	331
8.8	Non-Flat Plates	338
8.9	The Effect of an Added Mass or Mass-Spring System on Plate Vibrations	340
8.10	Small Disturbances	344
8.11	Plates Mounted on Resilient Layers	347
8.12	Vibration of Orthotropic Plates	353
8.13	Circular and Homogeneous Plates	354
8.14	Bending of Plates in Tension	360
	Problems	362
	References	365
	Index	369