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1.2 Principles of mathematical modeling; 1.3 Some methods of mathematical modeling; 1.4 Summary; 1.5 References; 2 Dimensional Analysis; 2.1 Dimensions and units; 2.2 Dimensional homogeneity; 2.3 Why do we do dimensional analysis?; 2.4 How do we do dimensional analysis?; 2.5 Systems of units; 2.6 Summary; 2.7 References; 2.8 Problems; 3 Scale; 3.1 Abstraction and scale; 3.2 Size and shape: geometric scaling; 3.3 Size and function-I: Birds and flight; 3.4 Size and function-II: Hearing and speech; 3.5 Size and limits: scale in equations; 3.6 Consequences of choosing a scale; 3.7 Summary; 3.8 References; 3.9 Problems; 4 Approximating and Validating Models; 4.1 Taylor's formula; 4.2 Algebraic approximations; 4.3 Numerical approximations: significant figures; 4.4 Validating the model-I: How do we know the model is OK?; 4.5 Validating the model-II: How large are the errors?; 4.6 Fitting curves to data; 4.7 Elementary statistics; 4.8 Summary; 4.9 Appendix: Elementary transcendental functions; 4.10 References; 4.11 Problems; Part B: Applications

5 Exponential Growth and Decay; 5.1 How do things get so out of hand?; 5.2 Exponential functions and their differential equations; 5.3 Radioactive decay; 5.4 Charging and discharging a capacitor; 5.5 Exponential models in money matters; 5.6 A nonlinear model of population growth; 5.7 A coupled model of fighting armies; 5.8 Summary; 5.9 References; 5.10 Problems; 6 Traffic Flow Models; 6.1 Can we really make sense of freeway traffic?; 6.2 Macroscopic traffic flow models; 6.3 Microscopic traffic models; 6.4 Summary; 6.5 References; 6.6 Problems; 7 Modeling Free Vibration; 7.1 The freely-vibrating pendulum-I: Formulating a model; 7.2 The freely-vibrating pendulum-II: The linear model; 7.3 The spring-mass oscillator-I: Physical interpretations; 7.4 Stability of a two-mass pendulum; 7.5 The freely vibrating pendulum-III: The nonlinear model; 7.6 Modeling the popular growth of coupled species; 7.7 Summary; 7.8 References; 7.9 Problems; 8 Applying Vibration Models; 8.1 The spring-mass oscillator-II: Extensions and analogies; 8.2 The fundamental period of a tall, slender building; 8.3 The cyclotron frequency; 8.4 The fundamental frequency of an acoustic resonator; 8.5 Forcing vibration: modeling an automobile suspension; 8.6 The differential equation $m \frac{d^2x}{dt^2} + kx = F(t)$; 8.7 Resonance and impedance in forced vibration; 8.8 Summary; 8.9 References; 8.10 Problems; 9 Optimization: What Is the Best...?; 9.1 Continuous optimization modelling; 9.2 Optimization with linear programming; 9.3 The transportation problem; 9.4 Choosing the best alternative; 9.5 A miscellany of optimization problems; 9.6 Summary; 9.7 References; 9.8 Problems; Index

Sommario/riassunto

Science and engineering students depend heavily on concepts of mathematical modeling. In an age where almost everything is done on a computer, author Clive Dym believes that students need to understand and "own" the underlying mathematics that computers are doing on their behalf. His goal for *Principles of Mathematical Modeling, Second Edition*, is to engage the student reader in developing a foundational understanding of the subject that will serve them well into their careers. The first half of the book begins with a clearly defined set of modeling principles, and then intro