CONTENTS

About the Authors ix Preface xi Preface to the SI Edition xviii Digital Resources xix Symbols xxii Greek Alphabet xxv

- 1. Tension, Compression, and Shear 1
 - 1.1 Introduction to Mechanics of Materials 2

*2.9 Repeated Loading and Fatigue 209
*2.10 Stress Concentrations 211
*2.11 Nonlinear Behavior 218
*2.12 Elastoplastic Analysis 222
Chapter Summary and Review 229
Problems 231
Some Additional Review Problems 276

3. Torsion 281

- 3.1 Introduction 282
- 3.2 Torsional Deformations of a Circular Bar 282

- 1.2 Problem-Solving Approach 2
- 1.3 Statics Review 3
- 1.4 Normal Stress and Strain 22
- 1.5 Mechanical Properties of Materials 31
- 1.6 Elasticity, Plasticity, and Creep 38
- 1.7 Linear Elasticity, Hooke's Law, and Poisson's Ratio 44
- 1.8 Shear Stress and Strain 50
- 1.9 Allowable Stresses and Allowable Loads 63
- 1.10 Design For Axial Loads and Direct Shear 70
 Chapter Summary and Review 74
 Problems 77
 Some Additional Review Problems 119

- **3.3** Circular Bars of Linearly Elastic Materials 285
- 3.4 Nonuniform Torsion 298
- **3.5** Stresses and Strains in Pure Shear 310
- **3.6** Relationship Between Moduli of Elasticity E and G 317
- **3.7** Transmission of Power by Circular Shafts 319
- **3.8** Statically Indeterminate Torsional Members 323
- **3.9** Strain Energy in Torsion and Pure Shear 327
- **3.10** Torsion of Noncircular Prismatic Shafts 334
- 3.11 Thin-Walled Tubes 344

2. Axially Loaded Members 123

- 2.1 Introduction 124
- 2.2 Changes in Lengths of Axially Loaded Members 124
- 2.3 Changes in Lengths under Nonuniform Conditions 132
- 2.4 Statically Indeterminate Structures 146
- 2.5 Thermal Effects, Misfits, and Prestrains 159
- 2.6 Stresses on Inclined Sections 178
- 2.7 Strain Energy 190
- *2.8 Impact Loading 201

 *3.12 Stress Concentrations in Torsion 352 Chapter Summary and Review 357 Problems 360 Some Additional Review Problems 385

4. Shear Forces and Bending Moments 389

- 4.1 Introduction 390
- 4.2 Types of Beams, Loads, and Reactions 390
- 4.3 Shear Forces and Bending Moments 400
- 4.4 Relationships Among Loads, Shear Forces, and Bending Moments 408

Contents

vi

4.5 Shear-Force and Bending-Moment Diagrams 412
Chapter Summary and Review 439
Problems 441
Some Additional Review Problems 456

5. Stresses in Beams (Basic Topics) 459

- 5.1 Introduction 460
- 5.2 Pure Bending and Nonuniform Bending 460
- 5.3 Curvature of a Beam 461
- 5.4 Longitudinal Strains in Beams 463
- 5.5 Normal Stresses in Beams(Linearly Elastic Materials) 467

- 6.9 Shear Centers of Thin-Walled Open Sections 613
- *6.10 Elastoplastic Bending 621
 Chapter Summary and Review 630
 Problems 632
 Some Additional Review Problems 654

7. Analysis of Stress and Strain 657

- 7.1 Introduction 658
- 7.2 Plane Stress 658
- 7.3 Principal Stresses and Maximum Shear Stresses 666
- 7.4 Mohr's Circle for Plane Stress 674
- 7.5 Hooke's Law for Plane Stress 687

- 5.6 Design of Beams for Bending Stresses 480
- 5.7 Nonprismatic Beams 490
- 5.8 Shear Stresses in Beams of Rectangular Cross Section 494
- 5.9 Shear Stresses in Beams of Circular Cross Section 502
- 5.10 Shear Stresses in the Webs of Beams with Flanges 505
- *5.11 Built-Up Beams and Shear Flow 512
- *5.12 Beams with Axial Loads 516
- *5.13 Stress Concentrations in Bending 523 Chapter Summary and Review 528 Problems 532

Some Additional Review Problems 566

- 7.6 Triaxial Stress 693
- 7.7 Plane Strain 697
 - Chapter Summary and Review 712 Problems 715 Some Additional Review Problems 737
- 8. Applications of Plane Stress (Pressure Vessels, Beams, and Combined Loadings) 739
 - 8.1 Introduction 740
 - 8.2 Spherical Pressure Vessels 740
 - 8.3 Cylindrical Pressure Vessels 746
 - 8.4 Maximum Stresses in Beams 753
 - 8.5 Combined Loadings 761
 Chapter Summary and Review 786

6. Stresses in Beams (Advanced Topics) 569

- 6.1 Introduction 570
- 6.2 Composite Beams 570
- 6.3 Transformed-Section Method 579
- 6.4 Doubly Symmetric Beams with Inclined Loads 587
- 6.5 Bending of Unsymmetric Beams 594
- 6.6 The Shear-Center Concept 605
- 6.7 Shear Stresses in Beams of Thin-Walled Open Cross Sections 606
- 6.8 Shear Stresses in Wide-Flange Beams 609

Problems 788 Some Additional Review Problems 807

- 9. Deflections of Beams 811
 - 9.1 Introduction 812
 - **9.2** Differential Equations of the Deflection Curve 812
 - **9.3** Deflections by Integration of the Bending-Moment Equation 817
 - 9.4 Deflections by Integration of the Shear-Force and Load Equations 828
 - 9.5 Method of Superposition 833
 - 9.6 Moment-Area Method 842

9.7 Nonprismatic Beams 850

- 9.8 Strain Energy of Bending 855
- *9.9 Castigliano's Theorem 860
- *9.10 Deflections Produced by Impact 872
- *9.11 Temperature Effects 874 Chapter Summary and Review 878 Problems 880 Some Additional Review Problems 90

Some Additional Review Problems 906

10. Statically Indeterminate Beams 909

- 10.1 Introduction 910
- 10.2 Types of Statically Indeterminate Beams 910

- 11.5 Columns with Eccentric Axial Loads 990
- 11.6 The Secant Formula for Columns 995
- 11.7 Elastic and Inelastic Column Behavior 1000
- 11.8 Inelastic Buckling 1002
 Chapter Summary and Review 1008
 Problems 1011
 Some Additional Review Problems 1029

References and Historical Notes 1033 APPENDIX A: Systems of Units 1042 APPENDIX B: Problem Solving 1050 APPENDIX C: Mathematical Formulas 1058 APPENDIX D: Review of Centroids and Moments of Inertia 1063 APPENDIX E: Properties of Plane Areas 1089 APPENDIX F: Properties of Structural-Steel Shapes 1095 APPENDIX G: Properties of Structural Timber 1101 APPENDIX H: Deflections and Slopes of Beams 1102 APPENDIX I: Properties of Materials 1108 Answers to Problems 1113

10.3 Analysis by the Differential Equations of the Deflection Curve 913
10.4 Method of Superposition 919
*10.5 Temperature Effects 933
*10.6 Longitudinal Displacements at the Ends of a Beam 940
Chapter Summary and Review 943
Problems 945
Some Additional Review
Problems 958

11. Columns 963

11.1 Introduction 964
11.2 Buckling and Stability 964
11.3 Columns with Pinned Ends 972
11.4 Columns with Other Support

Conditions 981

Index 1150

A Gere (1925-2008) earned his undergraduate and master's degree in Engineering from the Rensselver Polytechnic Institute in 1949 and 1951. Second werked is an institutor and later as a Research Associate for Second and the was awarded the of the first MSF Fellowships, and chose to second second the received his Ph.D in 1954 and was offered a faculty position of the first MSF Fellowships, and chose to second the first MSF Fellowships, and chose to second second Engineering beginning a 34-year career of engaging his students in careful Engineering beginning a 34-year career of engaging his students in the topic of the topic of the first of the first of the first of the and the second second as Department Chair and Associate Dean of Engineering and in 1974 and the John A. Blame Earthquake Engineering Center at Stunford, In first Gere also became the fourning head of the Stanford Committee on

s on branchord in 1988, but continued to be an active and most valuable member

*A star attached to a section number indicates a specialized and/or advanced topic.

Courtesy of James and Janice Gere Family Trust