Contents

James Monroe Gere ix
Photo Credits x
Preface xi
Symbols xv
Greek Alphabet xviii

1	Tension, Compression, and Shear	2
	1.1	Introduction to Mechanics of Materials 5
	1.2	Normal Stress and Strain 7
	4.3	Mechanical Properties of Materials 15
	1.4	Elasticity, Plasticity, and Creep 24
	8.5	Linear Elasticity, Hooke's Law, and Poisson's Ratio 27
	1.6	Shear Stress and Strain 32
	1.7	Allowable Stresses and Allowable Loads 43
	1.8	Design for Axial Loads and Direct Shear 49
		Chapter Summary & Review 55
		Problems 57
2	Axially Loaded Members 88	
	2.1	Introduction 91
	2.2	Changes in Lengths of Axially Loaded Members 91
	2.3	Changes in Lengths Under Nonuniform Conditions 100
	2.4	Statically Indeterminate Structures 107
	2.5	Thermal Effects, Misfits, and Prestrains 116
	2.6	Stresses on Inclined Sections 128
	2.7	Strain Energy 140
	★ 2.8	Impact Loading 153
	★2 .%	Repeated Loading and Fatigue 162
	* 2.10	Stress Concentrations 164
	*2.11	Nonlinear Behavior 170

[★] Specialized and/or advanced topics

			Chapter Summary & Review 181 Problems 182
3	Torsion	220	
		4.1	Introduction 222
		3 .∜	Torsional Deformations of a Circular Bar 223
		3.3	Circular Bars of Linearly Elastic Materials 226
		3.4	Nonuniform Torsion 238
		3.5	Stresses and Strains in Pure Shear 245
		3.6	Relationship Between Moduli of Elasticity E and G 252
		3.7	Transmission of Power by Circular Shafts 254
		3.8	Statically Indeterminate Torsional Members 259
		3.9	Strain Energy in Torsion and Pure Shear 263
		3.10	Thin-Walled Tubes 270
		★ 3, \$\$	Stress Concentrations in Torsion 279
			Chapter Summary & Review 282
			Problems 283
4	Shear Forces and Bending Moments 304		
		4.1	Introduction 306
		4.2	Types of Beams, Loads, and Reactions 306
		4.3	Shear Forces and Bending Moments 313
		4,4	Relationships Between Loads, Shear Forces,
			and Bending Moments 320
		4,5	Shear-Force and Bending-Moment Diagrams 325
			Chapter Summary & Review 337
			Problems 338
5	Stresse	s in Beams (Basic Topics)	350
		5.1	Introduction 353
		5.2	Pure Bending and Nonuniform Bending 353
		5.3	Curvature of a Beam 354
		5.4	Longitudinal Strains in Beams 356
		5.5	Normal Stresses in Beams (Linearly Elastic Materials) 361
		5.6	Design of Beams for Bending Stresses 374
		5.7	Nonprismatic Beams 383
		5.8	Shear Stresses in Beams of Rectangular Cross Section 387
		5.9	Shear Stresses in Beams of Circular Cross Section 397
		5.10	Shear Stresses in the Webs of Beams with Flanges 400

Elastoplastic Analysis 175

	**\$\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Stress Concentrations in Bending 418	
		Chapter Summary & Review 421	
		Problems 424	
6	Stresses in Beams (Advanced Topics) 454		
	6.1	Introduction 457	
	6.2	Composite Beams 457	
	5.3	Transformed-Section Method 466	
	5.4	Doubly Symmetric Beams with Inclined Loads 472	
	\$.5	Bending of Unsymmetric Beams 479	
	5.5	The Shear-Center Concept 487	
	The state of the s	Shear Stresses in Beams of Thin-Walled Open Cross Sections 489	
	# # # # # # # # # # # # # # # # # # #	Shear Stresses in Wide-Flange Beams 492	
	6.9	Shear Centers of Thin-Walled Open Sections 496	
	**6.10	Elastoplastic Bending 504	
		Chapter Summary & Review 514	
		Problems 516	
7	Analysis of Stress and Strain 536		
	7,2	Introduction 539	
	7.2	Plane Stress 540	
	7.3	Principal Stresses and Maximum Shear Stresses 548	
	7.4	Mohr's Circle for Plane Stress 558	
	7.49	Hooke's Law for Plane Stress 575	
	7.6	Triaxial Stress 580	
	7.7	Plane Strain 584	
		Chapter Summary & Review 600	
		Problems 602	
8	Applications of Plane Stress (Press	sure Vessels, Beams, and Combined Loadings) 618	
	8,1	Introduction 621	
	3.2	Spherical Pressure Vessels 621	
	8.3	Cylindrical Pressure Vessels 627	
	8.4	Maximum Stresses in Beams 635	
	8.5	Combined Loadings 645	
		Chapter Summary & Review 661	
		Problems 663	
	** Ac	dvanced topics	

Built-Up Beams and Shear Flow 408

Beams with Axial Loads 412

**5,11

**5.12

9	Deflections of Beams	676	
		9.1	Introduction 679
		9.2	Differential Equations of the Deflection Curve 679
		9.3	Deflections by Integration of the Bending-Moment Equation 685
		養養	Deflections by Integration of the Shear-Force
			and Load Equations 696
		9.5	Method of Superposition 702
		9.6	Moment-Area Method 711
		9.7	Nonprismatic Beams 720
		9.8	Strain Energy of Bending 725
		**9.9	Castigliano's Theorem 731
		**9.10	Deflections Produced by Impact 744
		***	Temperature Effects 746
			Chapter Summary & Review 749
			Problems 751
10	Statically Indetermina	te Beams 7	770
		10.1	Introduction 773
		10.2	Types of Statically Indeterminate Beams 773
		10.3	Analysis by the Differential Equations
			of the Deflection Curve 777
		10.4	Method of Superposition 784
		**10.5	Temperature Effects 797
		**10.6	Longitudinal Displacements at the Ends of a Beam 801
			Chapter Summary & Review 805
			Problems 806
11	Columns 816		
		11.1	Introduction 819
		11.2	Buckling and Stability 819
		11.3	Columns with Pinned Ends 823
		11.4	Columns with Other Support Conditions 834
		11.5	Columns with Eccentric Axial Loads 845
		11.6	The Secant Formula for Columns 850
			Elastic and Inelastic Column Behavior 856

^{**} Advanced topics

	11.8 Inelastic Buckling 858 Chapter Summary & Review 864 Problems 865
12 Review of Centroids and	Moments of Inertia 878
	Introduction 880 Centroids of Plane Areas 880 Centroids of Composite Areas 883 Moments of Inertia of Plane Areas 887 Parallel-Axis Theorem for Moments of Inertia 890 Polar Moments of Inertia 894 Products of Inertia 896 Rotation of Axes 899 Principal Axes and Principal Moments of Inertia 901
	Problems 905 References and Historical Notes 913 Appendix A Systems of Units and Conversion Factors 921
	A.1 Systems of Units 921 A.2 SI Units 922 A.3 Temperature Units 929
	Appendix B Problem Solving 930 8.1 Types of Problems 930 8.2 Steps in Solving Problems 931 8.3 Dimensional Homogeneity 932 8.4 Significant Digits 933 8.5 Rounding of Numbers 935
	Appendix C Mathematical Formulas 936 Appendix D Properties of Plane Areas 940
	Appendix E Properties of Structural-Steel Shapes 946

- **Appendix F** Properties of Structural Lumber 952
- **Appendix G Deflections and Slopes of Beams** 953
- **Appendix H** Properties of Materials 959
- **Answers to Problems** 965
- Name Index 986
- **Subject Index** 987