

CONTENTS

1. Mechanical Tests and Polymer Transitions	1
I. Introduction	1
II. Mechanical Tests	3
III. Glass Transitions	16
IV. Crystallinity	23
2. Elastic Moduli	33
I. Isotropic and Anisotropic Materials	33
II. Methods of Measuring Moduli	36
III. Relations of Moduli to Molecular Structure	43
3. Creep and Stress Relaxation	63
I. Introduction	63
II. Models	64
III. Distribution of Relaxation and Retardation Times	69
IV. Superposition Principles	73
V. Nonlinear Response	82
VI. Effect of Pressure	87
VII. Thermal Treatments	87
VIII. Effect of Molecular Weight: Molecular Theory	89
IX. Effect of Plasticizers on Melt Viscosity	100
X. Cross-linking	102
XI. Crystallinity	109
XII. Copolymers and Plasticization I	113
XIII. Effect of Orientation	115
XIV. Block Polymers and Polyblends	117
Summary	118
Problems	120
References	123
4. Dynamical Mechanical Properties	131
I. Introduction	131
II. Temperature and Frequency Effects	135
III. Stress or Strain Amplitude Effects	154
IV. Thermal History	157
V. Effect of Molecular Weight	159

VI. Effect of Cross-linking	167
VII. Effect of Crystallinity and Morphology	175
VIII. Effect of Plasticizers and Copolymerization	181
IX. Effect of Molecular Orientation	188
X. Effect of Strength of Intermolecular Forces	194
XI. Polyblends, Block, and Graft Polymers	197
XII. Secondary Damping Peaks	202
Summary	212
Problems	213
References	217
5. Stress – Strain Behavior and Strength	233
I. Stress – Strain Tests	233
II. Brittle Fracture and Stress Concentrators	295
III. Impact of Yielding and Cold – drawing	299
IV. Impact Strength and Tearing	307
Summary	318
Problems	319
References	322
6. Other Mechanical Properties	337
I. Heat Distortion Temperature	337
II. Fatigue	342
III. Friction	352
IV. Abrasion. Wear, and Scratch Resistance	358
V. Hardness and Indentation Tests	362
VI. Stress Cracking and Crazing in Fluids	366
Summary	368
Problems	368
References	369
7. Particulate-Filled Polymers	377
I. Introduction to Composite Systems	377
II. Rheology of Suspensions	378
III. Relation between Viscosity and Shear Modulus	384
IV. Moduli of Filled Polymers	384
V. Strength and Stress – Strain Behavior	401
VI. Creep and Stress Relaxation	422
VII. Dynamic Mechanical Properties	425
VIII. Other Mechanical Properties	435

IX. Composites with Thick Interlayers	443
X. Syntactic Foams	444
XI. Structural Foams	445
Summary	446
Problems	447
References	450
8. Fiber-Filled Composites and Other Composites	461
I. Introduction	461
II. Moduli of Fiber-Filled Composites	463
III. Strength of Fiber-Filled Composites	471
IV. Other Properties	479
V. Ribbon-Filled Composites	495
VI. Other Types of Composites	499
Summary	503
Problems	504
References	505
Appendixes	515
I. Chemical Structure of Common Polymers	516
II. Conversion Factors for Moduli, Stress and Viscosity	519
III. Glass Transition Temperatures and Melting Points of Polymers	520
IV. Relations Between Engineering Moduli and Tensor Moduli and Tensor Compliances for Anisotropic Methods	524
V. On Rubberlike Elasticity	528
VI. List of Symbols	533
Index	545