## **Contents**

Chap	oter 1. What is Color? 1
Α.	What This Book is About 1
В.	The Physical Stimulus 2
	Sources of Light 4
	How Materials Modify Light 8 Transmission 8 Absorption 9 Scattering 10 Other Aspects of Appearance 11 The Spectral Characteristics of Materials 12
	Detecting Light and Color 12
	Summary 12
C.	The Description of Color 14
	The "Desert Island" Experiment 15
	Color Coordinates 17
D.	The Appearance of Color 18  Light Sources, Color Rendition, and Adaptation 18  Metamerism 20
Chaj	pter 2. Color-Order Systems 25
Α.	Systems Based on Physical Samples 25
	Random Arrangements 25
	Orderly Arrangements 26
	Arrangements Based on Principles 26
	The Munsell System 26
	The Ostwald System 30
В.	The CIE System 31
	Mixing Colored Lights 31
0	The 1931 CIE Sources, Observer, and Coordinates 38
C.	Uniform Chromaticity Systems 45
	Transformations of the CIE System 45 Other Percentually Uniform Systems 64

,	Single-Number Color Scales 50 Lightness Scales 51 Yellowness Scales 51 Whiteness Scales 52 Other One-Dimensional Color Scales 52
E.	Summary 52
Chap	ter 3. Color Measurement, Specification, and Tolerances 53
,	Basic Principles of Measuring Color 53 Examination 53 Assessment 54 THINK and LOOK 54
:	The Sample 55 Samples for Analysis 55 Form Suitable For Inspection 55 Again, LOOK 57
	Visual Color Measurement 57 Sample and Single Standard 57 Sample and Multiple Standards 58
1	Instruments Using the Eye as Detector 60 Disk Colorimetry 60 Color Comparators for Liquids 61 More-Refined Instruments 62
	Fully Instrumental Color Measurement 63  Classification of Methods 64  Unaltered Light 64  Three-Colored Lights 65  Monochromatic Light 65  Colorimetry 66  Source-Detector Response 66  Sample Viewing 67  Coordinate Scales 69  Instrument Metamerism 69  Standardization and Differential Use 71  Typical Commercial Instruments 72  Abridged Spectrophotometry 73  Spectrophotometry 74  Source of Spectrum 74  Sample Viewing 75  Standardization and Accuracy 77  Calculation of CIE Coordinates 77  Typical Commercial Instruments 79
F.	The Use of Instruments in Color Assessment 83
	Assessment with Limit Standards 83 Assessment by Color Difference 84

	Perceptibility Versus Acceptability 87 Color Tolerances 88
	Color Tolerances oo
G.	Summary 89
Chaj	pter 4. Colorants 91
Α.	Some Matters of Terminology 91
В.	Dyes Versus Pigments 93 Solubility 93
	Chemical Nature 94
	Transparency 94 Presence of a Binder 94
	Summary 95
C.	Classification of Colorants 95
D.	Selecting the Colorants to Use 97
	Sources of Information 97  Experienced Personnel 97  Suppliers of Colorants 97  Books and Periodicals 97  The User's Experience 97
	General Principles in Choosing Colorants 100
E.	Summary 100
	Sammary 200
Chal	pter 5. The Coloring of Materials in Industry 103
Chal	pter 5. The Coloring of Materials in Industry 103  Color Mixing Laws 103
Chal	pter 5. The Coloring of Materials in Industry 103  Color Mixing Laws 103
Chal	Color Mixing Laws 103 Additive Mixing 104
Chap A.	Color Mixing Laws 103 Additive Mixing 104 Simple-Subtractive Mixing 107
Chap A.	Color Mixing Laws 103 Additive Mixing 104 Simple-Subtractive Mixing 107 Complex-Subtractive Mixing 110
Chap A.	Color Mixing Laws 103 Additive Mixing 104 Simple-Subtractive Mixing 107 Complex-Subtractive Mixing 110 Color Matching 112 Selecting the Colorants 112 Invariant Matches 113 Colorant Identification 113 Conditional Matches 113
Chap A.	Color Mixing Laws 103 Additive Mixing 104 Simple-Subtractive Mixing 107 Complex-Subtractive Mixing 110 Color Matching 112 Selecting the Colorants 112 Invariant Matches 113 Colorant Identification 113 Conditional Matches 113 Summary 114 The Initial Match 114 Visual Matching 115 Instrumental Aids 115
Chap A. B.	Color Mixing Laws 103 Additive Mixing 104 Simple-Subtractive Mixing 107 Complex-Subtractive Mixing 110 Color Matching 112 Selecting the Colorants 112 Invariant Matches 113 Colorant Identification 113 Conditional Matches 113 Summary 114 The Initial Match 114 Visual Matching 115 Instrumental Aids 115 Computer Techniques 119
Chap A. B.	Color Mixing Laws 103 Additive Mixing 104 Simple-Subtractive Mixing 107 Complex-Subtractive Mixing 110 Color Matching 112 Selecting the Colorants 112 Invariant Matches 113 Colorant Identification 113 Conditional Matches 113 Summary 114 The Initial Match 114 Visual Matching 115 Instrumental Aids 115 Computer Techniques 119 Adjusting the Match 123 Color Control in Production 124 Monitoring 125 The Value of Instruments 125 The Effect of Process Variables 125

## Chapter 6. Color Technology-Present and Future 129

A. Color as an Engineering Material 129

The Various Meanings of Color 129

Engineering Properties of Colorants 131

Color Gamuts 132

The Selection of Colorants 136

B. Some Guesses About the Future 136

Colorimetry and the CIE System 137

New Illuminants 137

New Reflectance Standards 138

New Supplementary Standard Observer 138

Uniform Chromaticity System 140

New Color-Difference Formula 141

Instrumentation 141

Colorants 143

Color Matching 143

Education 144

## Chapter 7. Annotated Bibliography 145

A. Books 146

B. Journals, Yearbooks, and Other Serials 148

C. Color Perception and Appearance 149

D. Color-Order Systems 150

E. Color Measurement 152

F. Color Difference 154

G. Colorants 155

H. Color Matching and Formulation 156

Bibliography 161

Author Index 173

Subject Index 177