

CONTENTS

PREFACE	iii
Author	v
INTRODUCTION	1
1 BASIC TERMS	3
1.1 <i>Light</i>	3
1.2 <i>Blackbody radiation</i>	4
1.3 <i>Color</i>	6
1.3.1 Additive and subtractive mixing	8
1.4 <i>Color sensation</i>	9
2 Visual Evaluation of Colors	15
2.1 <i>Color order systems</i>	15
2.2 <i>Visual color measurements</i>	22
3 CIE colorimetry	25
3.1 <i>Standard light sources</i>	26
3.2 <i>Interaction of materials with radiation</i>	34
3.2.1 Geometric conditions for colorimetry	36
3.2.2 Measuring devices in colorimetry	38
3.3 <i>CIE standard observer</i>	43
3.3.1 Color matching functions	43
3.4 <i>CIE XYZ</i>	46
4 Color Difference measurement	51
4.1 <i>UCS</i>	51
4.1.1 MacAdam u, v diagram	53
4.1.2 Breckenridge - Schaub: RUCS	53
4.1.3 Hunter α, β diagram and NBS unit of color difference	53
4.1.4 Hunter - Scofield equation	54
4.1.5 CIE1964 $U^*V^*W^*$	55
4.1.6 CIE1976 $L^*u^*v^*$	55
4.1.7 FMC I	56
4.1.8 FMC II	59
4.1.9 OSA-UCS	61
4.2 <i>Munsell based scales</i>	61
4.2.1 ANLAB	62
4.2.2 Glasser Cube-Root	63
4.2.3 CIELAB	64
4.2.4 Hunter LAB	67
4.3 <i>Color-difference formulas</i>	68
4.3.1 CMC($l:c$)	68
4.3.2 CIE1994	69
4.3.3 M&S and Datacolor equations	69
4.3.4 DIN99 color difference formula	71
4.3.5 CIE2000	72
5 Whiteness measurement	75
5.1 <i>Visual evaluation of whiteness</i>	77
5.2 <i>Objective measurement of whiteness</i>	79

5.2.1	ISO Brightness	79
5.2.2	One-dimensional whiteness formulas	80
5.2.3	Two-dimensional whiteness formulas	81
5.3	<i>Yellowness index</i>	89
6	Shade sorting	91
7	Applied colorimetry	97
7.1	<i>Visual assessment of color difference</i>	97
7.2	<i>Measurement</i>	105
7.2.1	Sample preparation	105
7.2.2	Background effect	111
7.2.3	Errors of measurement	114
7.2.4	Source of errors	117
7.2.5	Measurement procedure	121
7.2.6	Maintenance of measuring systems	123
7.2.7	Uncertainty in measurement	125
7.3	<i>Color tolerance specifications</i>	129
7.3.1	Statistical Tolerance Limits	136
7.3.2	Tolerance and uncertainty	141
7.4	<i>Metamerism</i>	143
7.4.1	Special Indices of Metamerism	144
7.4.2	General Indices of Metamerism	145
7.4.3	Color-difference and metamerism index	146
7.5	<i>On-line measurement</i>	147
7.6	<i>Final reminder</i>	153
	REFERENCES	155
	Appendix contents	161
A	Tables representing colorimetric observers	162
B	Tables of colorimetric illuminants	167
C	Tables of indices	179
D	Supplementary colorimetric calculations	181
E	Illuminant-Observer Weights for Calculating Tristimulus VALUES	183