TABLE 3.4 Color Coordinate Systems

Color coordinate system	Description
1. *C.I.E. spectral primary system: R, G, B*	Monochromatic primary sources P_1, red = 700 nm, P_2, green = 546.1 nm, P_3, blue = 435.8 nm. Reference white has flat spectrum and $R = G = B = 1$. See Figs. 3.13 and 3.14 for spectral matching curves and chromaticity diagram.
2. *C.I.E. X, Y, Z system* Y = luminance	$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.490 & 0.310 & 0.200 \\ 0.177 & 0.813 & 0.011 \\ 0.000 & 0.010 & 0.990 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$
3. *C.I.E. uniform chromaticity scale (UCS) system: u, v, Y* u, v = chromaticities Y = luminance U, V, W = tristimulus values corresponding to u, v, w	$u = \dfrac{4X}{X + 15Y + 3Z} \equiv \dfrac{4x}{-2x + 12y + 3}$ $v = \dfrac{6Y}{X + 15Y + 3Z} \equiv \dfrac{6y}{-2x + 12y + 3}$ $U = \dfrac{2X}{3}, \; V = Y, \; W = \dfrac{-X + 3Y + Z}{2}$
4. U^*, V^*, W^* system (modified UCS system) Y = luminance [0.01, 1]	$U^* = 13W^*(u - u_0)$ $V^* = 13W^*(v - v_0)$ $W^* = 25(100Y)^{1/3} - 17, \; 1 \le 100Y \le 100$ u_0, v_0 = chromaticities of reference white W^* = contrast or brightness
5. S, θ, W^* system: S = saturation θ = hue W^* = brightness	$S = [(U^*)^2 + (V^*)^2]^{1/2} = 13W^*[(u - u_0)^2 + (v - v_0)^2]^{1/2}$ $\theta = \tan^{-1}\left(\dfrac{V^*}{U^*}\right) = \tan^{-1}[(v - v_0)/(u - u_0)], \; 0 \le \theta \le 2\pi$
6. *NTSC receiver primary system* R_N, G_N, B_N	Linear transformation of X, Y, Z. Is based on television phosphor primaries. Reference white is illuminant C for which $R_N = G_N = B_N = 1$. $\begin{bmatrix} R_N \\ G_N \\ B_N \end{bmatrix} = \begin{bmatrix} 1.910 & -0.533 & -0.288 \\ -0.985 & 2.000 & -0.028 \\ 0.058 & -0.118 & 0.896 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$
7. *NTSC transmission system:* Y = luminance I, Q = chrominances	$Y = 0.299R_N + 0.587G_N + 0.114B_N$ $I = 0.596R_N - 0.274G_N - 0.322B_N$ $Q = 0.211R_N - 0.523G_N + 0.312B_N$
8. L^*, a^*, b^* *system:* L^* = brightness a^* = red-green content b^* = yellow-blue content	$L^* = 25\left(\dfrac{100Y}{Y_0}\right)^{1/3} - 16, \; 1 \le 100Y \le 100$ $a^* = 500\left[\left(\dfrac{X}{X_0}\right)^{1/3} - \left(\dfrac{Y}{Y_0}\right)^{1/3}\right]$ $b^* = 200\left[\left(\dfrac{Y}{Y_0}\right)^{1/3} - \left(\dfrac{Z}{Z_0}\right)^{1/3}\right]$ X_0, Y_0, Z_0 = tristimulus values of the reference white