ex. session 1 IMS

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Exercise 1

a) To calculate the intensity for I and S we use the formula $\frac{R+G+B}{3}$ in our case $\frac{X+Y+Z}{3}$ (1)

$$I_S = \frac{300}{3} = 100 \tag{2}$$

$$I_A = \frac{350}{3} = 116,1 \tag{3}$$

b) The chromaticity values are :

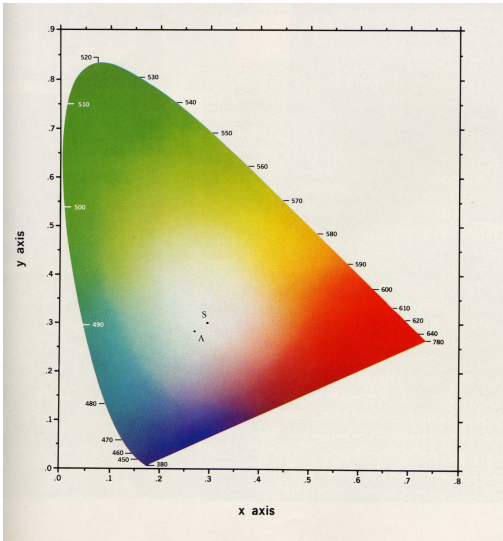
$$x_S = \frac{100}{300} = \frac{1}{3} \tag{4}$$

$$y_S = \frac{100}{300} = \frac{1}{3} \tag{5}$$

$$x_A = \frac{100}{350} = 0.28 \tag{6}$$

$$y_A = \frac{100}{350} = 0.28 \tag{7}$$

(8)



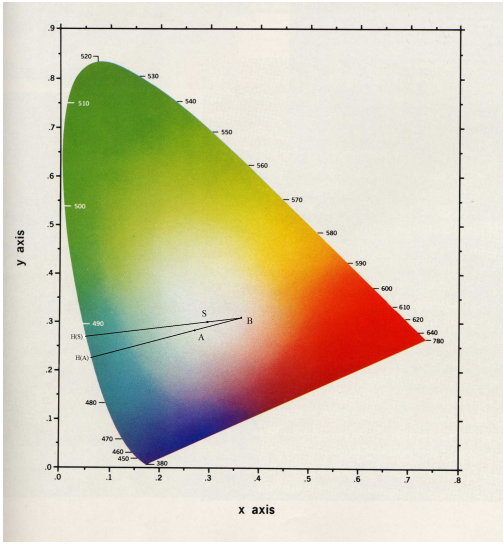
c)Hue is:

Having already calculated the chromaticity values for A and S (9)

$$x_B = \frac{x_B}{x_B + y_B + z_B} = \frac{120}{320} = 0.375 \tag{10}$$

$$y_B = \frac{y_B}{x_B + y_B + z_B} = \frac{100}{350} = 0.31 \tag{11}$$

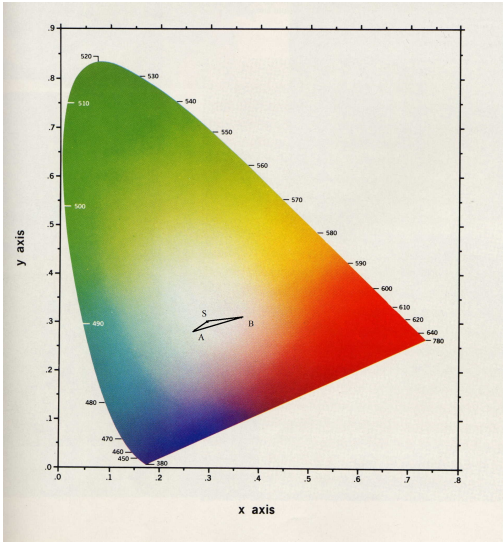
(12)



d)Saturation is higher when the values are closer to the edge. In our case :

$$S_A > S_B \tag{13}$$

e) The region of colors is:



Exercise 2

a) X, Y and Z are:

$$X = \int_{\lambda} k(\lambda)\bar{x}(\lambda)d\lambda \quad | \quad k(\lambda) = k \tag{14}$$

$$X = k\int_{\lambda} \bar{x}(\lambda)d\lambda \quad | \quad \lambda = 500nm \tag{15}$$

$$X = k\int_{\lambda} \rho(\lambda)\bar{x}(\lambda)d\lambda \quad | \quad \rho(\lambda) = \rho(\lambda_{500}) \tag{16}$$

$$X = k\rho(\lambda_{500})\bar{x}(\lambda_{500}) \tag{17}$$

$$X = k\bar{x}(\lambda_{500}) = k0.0049 \tag{18}$$

$$\text{we repeat for y and z} \tag{19}$$

$$Y = k\bar{y}(\lambda_{500}) = k0.323 \tag{20}$$

$$Y = k\bar{z}(\lambda_{500}) = k0.272 \tag{21}$$

$$\tag{22}$$

The chromaticity coordinates are :

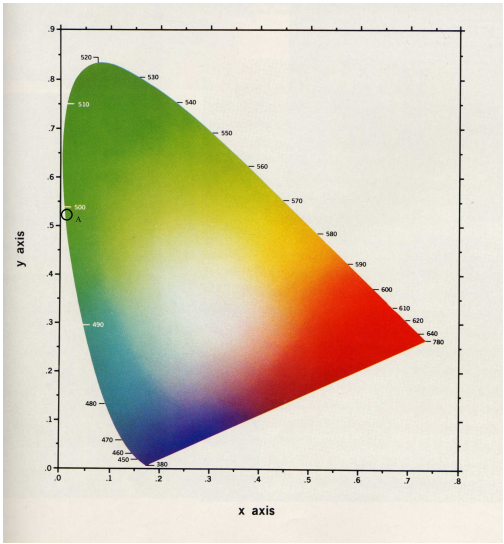
$$x_A = \frac{X_A}{X_A + Y_A + Z_A} = \frac{0.0049}{0.0049 + 0.323 + 0.272} = 0.0081 \tag{23}$$

$$y_A = 0.538 \tag{24}$$

$$z_A = 0.453 \tag{25}$$

$$\tag{26}$$

b)



c) We repeat the process described in a). The chromaticity coordinates are :

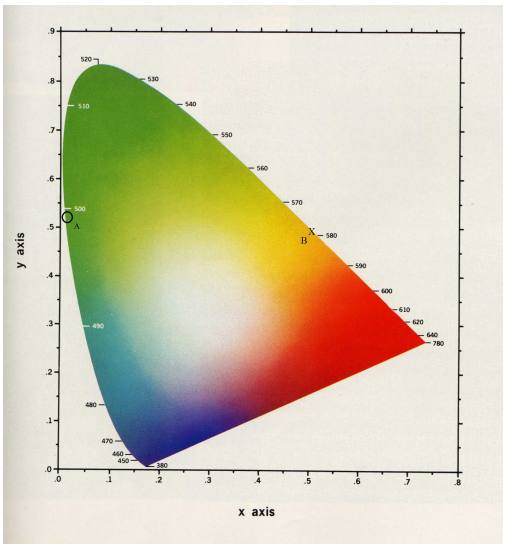
$$x_B = 0.51 \tag{27}$$

$$y_B = 0.48 \tag{28}$$

$$z_B = 0.0009 \tag{29}$$

$$\tag{30}$$

d)



e) The chromaticity coordinates for color C are :

$$x_C = \frac{X_A + X_B}{X_A + X_B + Y_A + Y_B + Z_A + Z_B} = \tag{31}$$

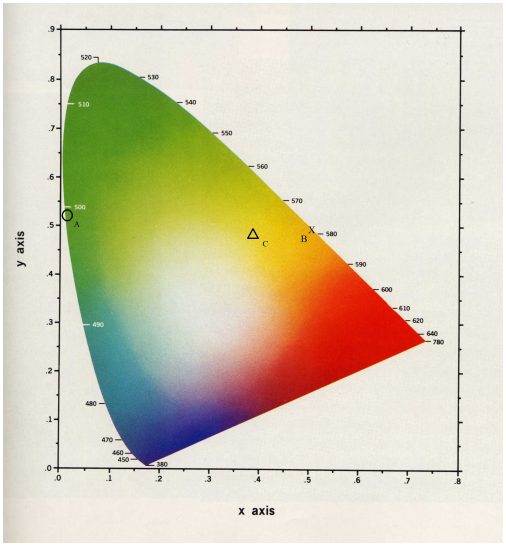
$$= \frac{0.0049 + 0.9163}{0.0049 + 0.9163 + 0.323 + 0.870 + 0.272 + 0.0017} = 0.38 \tag{32}$$

$$y_C = 0.459 \tag{33}$$

$$z_C = 0.114 \tag{34}$$

$$\tag{35}$$

f)



g) In the case of normalized colors xyz it is invariant to intensity, whereas in the XYZ system it they will change with K. A, B and C remain the same.

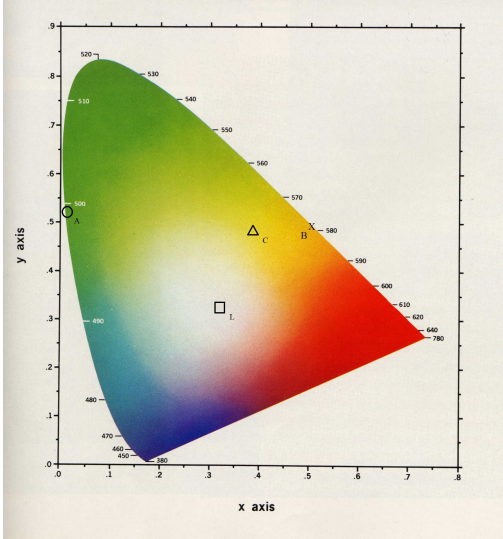
h)

$$x_L = \frac{X_L}{X_L + Y_L + Z_L} = \frac{98.04}{98.04 + 100 + 118.12} = 0.31 \tag{36}$$

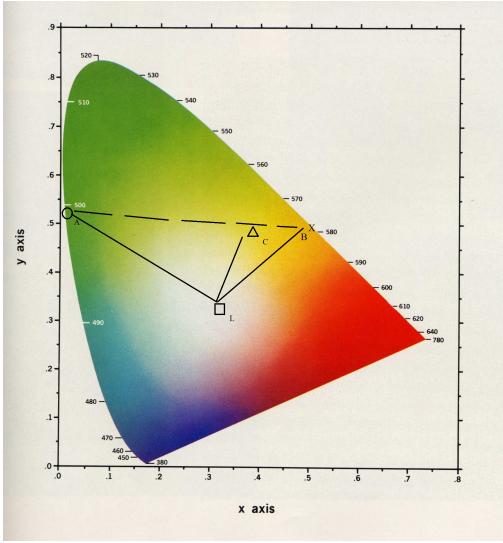
$$y_L = 0.316 \tag{37}$$

$$z_L = 0.373 \tag{38}$$

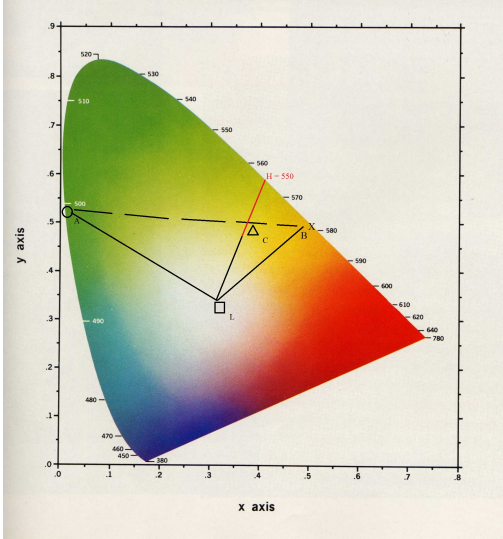
$$\tag{39}$$



i)



j) Hue = 550nm

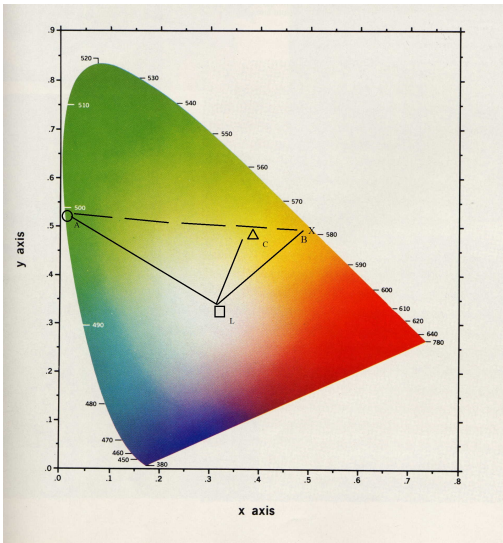


k) Reminder: the closer to the edge the more saturated a color is.

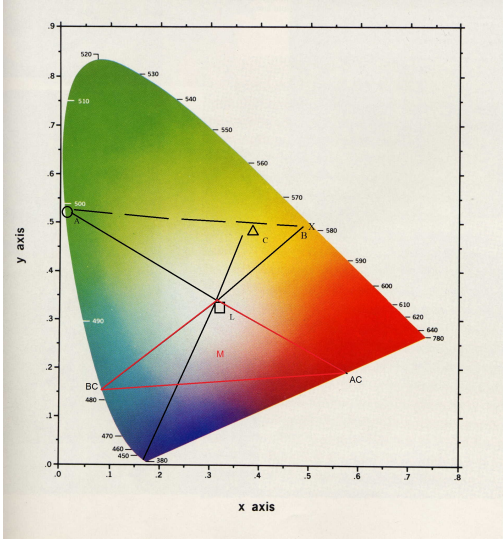
$$S_A = SB > S_C > S_L \tag{40}$$

(41)

l)Complementary colors: A does not have a complementary color because it is not a spectral color.

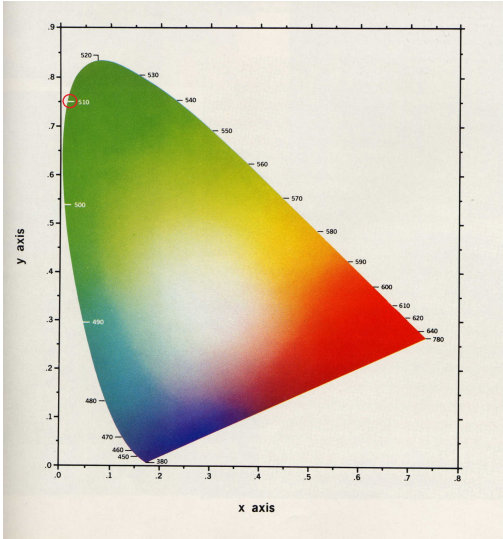


m)

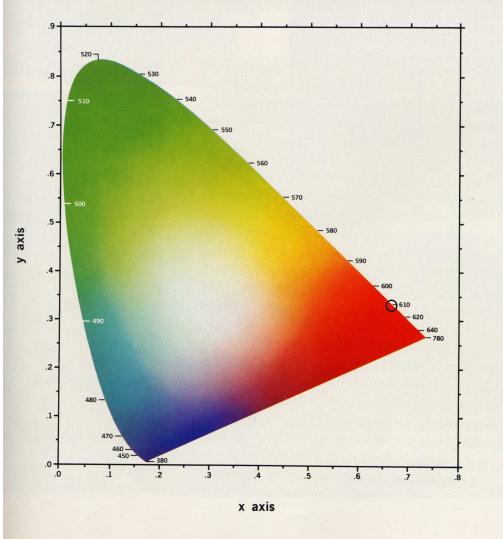


n) Dominant wavelength is 510nm. Approximated position is (look up values in the table):

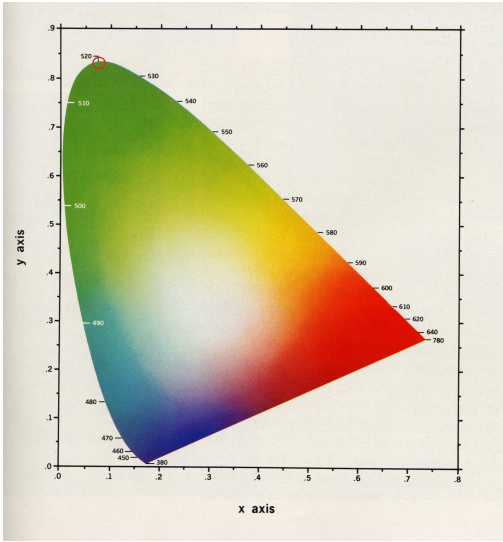
$$x = 0.013//y = 0.75 \tag{42}$$



o)Repeat process as described in n) DW = 610nm



p) DW = 520nm



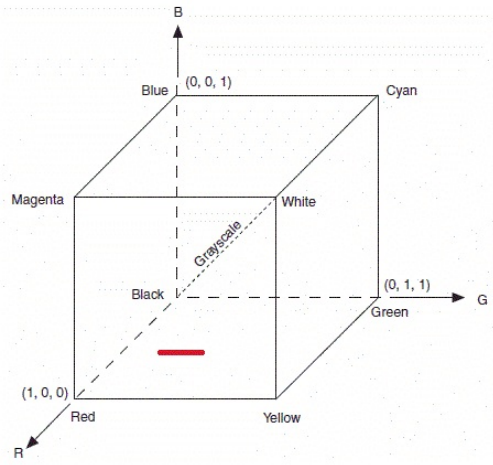
q) ??????lolwut (human eye is more sensitive to green afaik)

Exercise 3

a) Look up figure 1.5

$$R = IK_R cos\theta \tag{43}$$
$$G = IK_G cos\theta \tag{44}$$
$$B = IK_B cos\theta \tag{45}$$
$$cos\theta = \bar{n}\bar{l} \tag{46}$$
If the surface is flat then $\theta = 0$ and $cos\theta = 1$ thus I is constant. (47)
In the later case .. ?? to be updated (48)

b) R, G and B will change accordingly
c)



d)

$$R = IK_R cos\theta \tag{49}$$

$$G = IK_G cos\theta \tag{50}$$

$$\frac{R}{G} = \frac{IK_R cos\theta}{IK_G cos\theta} = \frac{K_R}{K_G} \tag{51}$$

independent of I; dependent only on the colors of the object (52)

e)
f)

Proof that $\frac{R}{G}$ is color invariant to shiny surfaces (53)

$$\frac{R}{G} = \frac{IK_R cos\theta + IK_S cos^n\alpha}{IK_G cos\theta + IK_S cos^n\alpha} = \text{independent of I; dependent only on the colors of the object} \tag{54}$$

Proof that $\frac{R-G}{R-B}$ is color invariant to shiny surfaces (55)

$$\frac{R-G}{R-B} = \frac{IK_R cos\theta + IK_S cos^n\alpha - (IK_G cos\theta + IK_S cos^n\alpha)}{IK_R cos\theta + IK_S cos^n\alpha - (IK_B cos\theta + IK_S cos^n\alpha} = \tag{56}$$

$$= \frac{Icos\theta(K_R - K_G)}{Icos\theta(K_R - K_B)} = \frac{K_R - K_G}{K_R - K_B} \tag{57}$$

only dependent on the color of the object (58)