# Video Signals
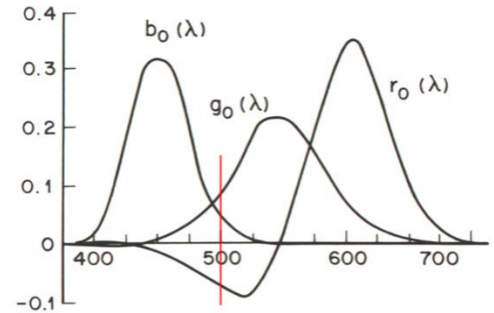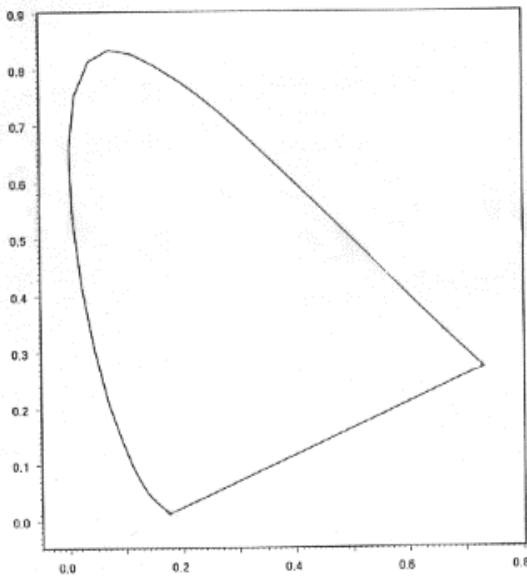
**Ex.1.[10 Pt]**
A cyan color is represented by a 500nm wavelength. The color matching functions have the following values: $r_0 = -0.07$, $g_0 = 0.085$, $b_0 = 0.048$
Explain the reason of the negative value of $r_0$ [**3Pt.**]



Provide the values of the X,Y,Z space given the following transformation matrix:

$$\frac{1}{0.18}\begin{bmatrix} 0.49 & 0.31 & 0.20 \\ 0.18 & 0.81 & 0.01 \\ 0.00 & 0.01 & 0.99 \end{bmatrix}$$ [**4Pt.**]

Indicate, after reproducing the CIE chromatic diagram on your exam sheet, the position of the described color [**3Pt.**].



**Es.2. [10 pt]**

Given a gray scale image with the following intensities:
$$\begin{bmatrix} 108 & 167 & 173 & 167 \\ 234 & 9 & 193 & 44 \\ 202 & 217 & 189 & 180 \\ 245 & 238 & 100 & 8 \end{bmatrix}$$
apply a 3x3 local binary pattern on the central pixels [**7pts**] an explain why it is robust to additive and multiplicative noise [**3Pt.**].

**Es.3. [10 pt]** It is over page

**Es.3. [10 pt]**



A lot of fake news and fake images are shared on social networks every day. The, obviously fake, image *trump_kim.png* (shown above) is a spliced image in which the Kim Jong-un head has been pasted in a picture in which Donald Trump shakes hands with someone else. As we can see, the original Kim image was probably affected by some kind of noise and this could be exploited to identify the altered region of the result image.

a) Read, load, visualize the grayscale image and save its height in variable called *h*.

b) Assuming a salt & pepper noise on Kim face, choose an appropriate 3x3 filter able to deal with it and apply it.

c) Save in an matrix the difference between the given image and the one obtained in b) (hint: convert the two matrices to double before performing the difference in order to store also negative values). Then select as a threshold value the 10% of the maximum absolute values of the differences. Finally build a binary image mask setting as ones the pixels in which the absolute value of the difference exceed the threshold.

d) In order to select the altered area of the image, perform two consecutive morphological operations of your choice on the mask obtained in c) (hint: expand the isolated points and subsequently discard small regions). For the two operations use two different square structuring elements with side h/40 and h/10 respectively.
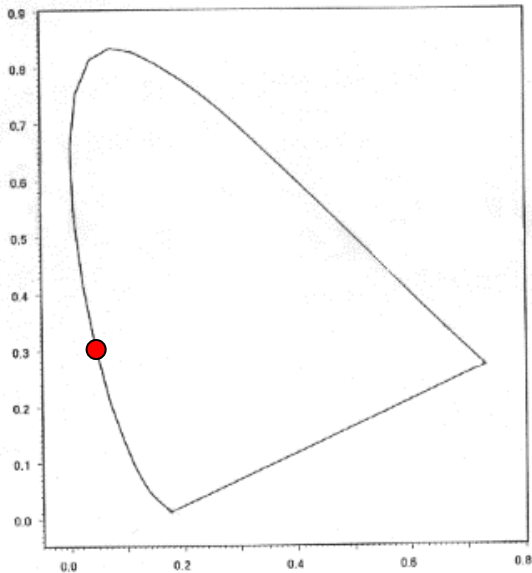
**Matlab List of possible functions**

```
figure
imread
medfilt2
imfilter
imshow
find
imhist
imopen
imclose
```

# Solutions

## Ex.1 The XYZ coordinates are:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \frac{1}{0.18} \begin{bmatrix} 0.49 & 0.31 & 0.20 \\ 0.18 & 0.81 & 0.01 \\ 0.00 & 0.01 & 0.99 \end{bmatrix} \begin{bmatrix} -0.07 \\ 0.085 \\ 0.048 \end{bmatrix} = \begin{bmatrix} 0.0092 \\ 0.3152 \\ 0.2687 \end{bmatrix}$$



## Ex.2

Analyzing the neighbourhood of every central pixel, applying the Local Binary Pattern starting from East and moving in a counter clock-wise we get as a result the following four values:
9-> 00000000b=0
193->11111011b=251
217->11101001=233
189->11010011=211

## Ex.3

```
close all
clear all

%a)
A = imread('trump_kim.png');
figure; imshow(A);
h = size(A,1);

%b)
A_median = medfilt2(A,[3 3]);

%c)
diff = double(A)-double(A_median);
thr=0.1*max(abs((diff(:))));
diff = diff<-thr | diff>thr;
```

```matlab
%d)
B=strel('square',h/40);
diff_open = imdilate(diff, B);
B=strel('square',h/10);
mask = imopen(diff_open, B);
```