# Lab 3. Färg

## Del 3- Laboration
## Svarsdokument

**Spara detta dokument som .pdf dokument innan ni lämnar in det på Lisam.**

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*Version (ifall ni behöver lämna retur): 1*

## 1) Working with Spectral Power Distribution

**Uppgift 1.1)**
XYZ values for CIED65:
X= 95.0437
Y= 100.0
Z= 108.8818

**Uppgift 1.2)**

**XYZ values for R1, under CIED65:** X= 40.0489, Y= 49.7395, Z=26.6104

**XYZ values for R2, under CIED65:** X= 40.0489, Y= 49.7395, Z=26.6104

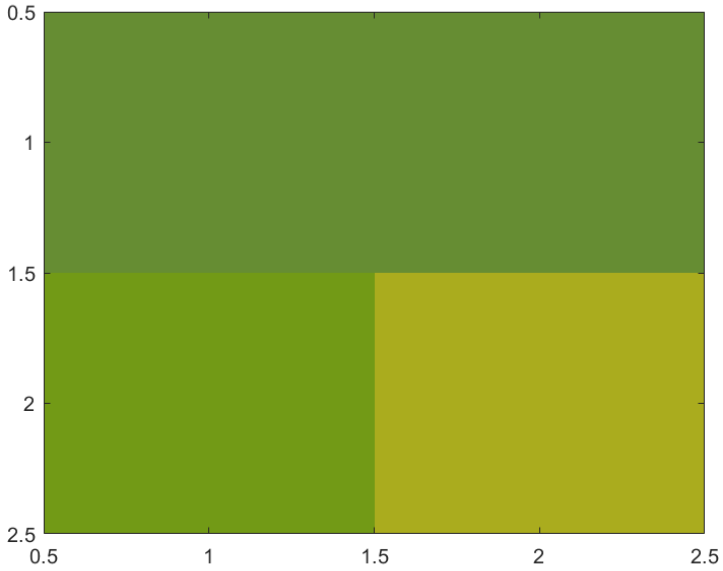
**Uppgift 1.3)**

**XYZ values for R1, under f11:** X=41,6587, Y=53,3569, Z=16,3345

**XYZ values for R2, under f11:** X=53,9818, Y=63,4675, Z= 20,7173

**Uppgift 1.4)**
A clear example metamerism, the color is perceived as the same under one light while different under another.

**Uppgift 1.5)**
Insert the figure here: (You can save this figure using File in the window, and then save as…, *yourfilename.png*. It is ok to scale down the image after inserting it in words)




What has happened to the white point in the xy chromaticity diagram when changing the light source?
The white point moves depending on the light source. Ex generally the white point moves closer to the blue/violet part of the chromaticity diagram in correspondence to higher temperatures.

Does that show in the colors?
You can see this in how CIED65 resulted in darker shades compared to f11.

**Uppgift 1.6)**
Explain briefly what color matching functions ($\bar{x}(\lambda)$ , $\bar{y}(\lambda)$ and $\bar{z}(\lambda)$) are and what they represent.

The color matching functions are approximations meant to replace the sensitivity functions for the different cone types since they are not known. For example, $\bar{y}(\lambda)$ represents the eye's spectral luminous efficiency curve (for high light levels). These values are derived from x(λ), y(λ), z(λ)

**Uppgift 1.7)**
Explain why the CIEY-value of a light source is always equal to 100 by referring to Equation 1.4 in the theory document.

Yn(λ) is always equal to 100 since the Yn value represents the luminosity of the white point. It is the brightest point and therefore 100.

## 2) Dot-on-Dot and Dot-off-Dot Halftoning

**Uppgift 2.1)**

Write the XYZ-values for dot-on-dot and dot-off-dot in the below table:
Ap = 0.5
Ab = 0.5

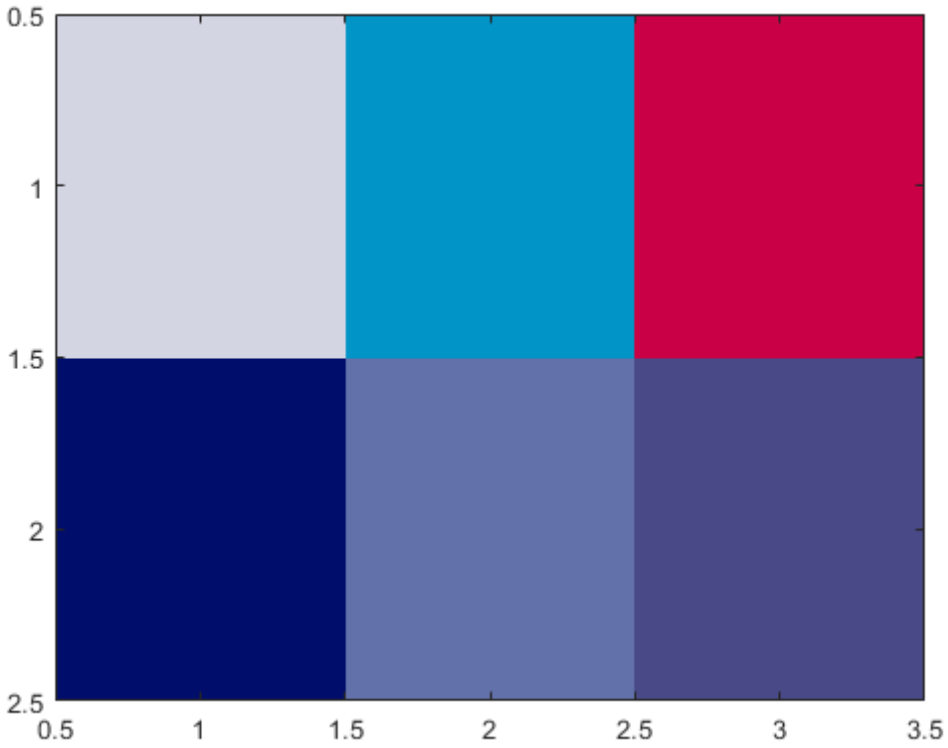
Ac = 0.5
Am = 0.5

| | X | Y | Z |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Dot-on-dot | 43.915 | 44.87 | 68,43 |
| Dot-off-dot | 31.6 | 30.48 | 54.2 |

**Uppgift 2.2)**

Insert the figure here: (You can save this figure using File in the window, and then save as…, *yourfilename.png*. It is ok to scale down the image after inserting it in words)




Is there a noticeable difference between dot-on-dot and dot-off-dot? For example, which one is darker? Why?

Dot-on-dot is brighter than dot-off-dot since 50% of the image is white representing the paper compared to the dot-off-dot where there is no white spots left.

**Uppgift 2.3)**

Could you use this function in all applications? Is this function device independent?

No, since not all system uses the same white spot on their color gambit, this results in colors being perceived in different ways depending on the system. Although D65 is rather common on displays since the function is not device independent it would not give the same results on all applications.

## 3) Color Halftoning According to Demichel

**Uppgift 3.1)**

**Notice,** Column 1 in the below table should be filled by your calculations in **uppgift 4** in the preparation part of this lab.

Fill column 2, Test 1, by your results using C1, M1, Y1 and K1.

Fill column 3, Test 2, by your results after simulating misregistration.
**Describe also** which channels and how many pixels and in each direction, you chose to simulate misregistration.

The C and Y channels are shifted to 139:394

| Ink | Demichel | Test 1 | Test 2 |
|---|---|---|---|
| *None* | 0.189 | 0.1628 | 0.1868 |
| *Only C* | 0.081 | 0.0765 | 0.0833 |
| *Only M* | 0.126 | 0.1351 | 0.1170 |
| *Only Y* | 0.189 | 0.2090 | 0.1757 |
| *Only K* | 0.021 | 0.0191 | 0.0221 |
| *Only C & M (Blue)* | 0.054 | 0.0648 | 0.0566 |
| *Only C & Y (Green)* | 0.081 | 0.0858 | 0.0881 |
| *Only C & K* | 0.009 | 0.0096 | 0.0103 |
| *Only M & Y (Red)* | 0.126 | 0.1126 | 0.1399 |
| *Only M & K* | 0.014 | 0.0185 | 0.0107 |
| *Only Y & K* | 0.021 | 0.0120 | 0.0138 |
| *C & M & Y* | 0.054 | 0.0509 | 0.0499 |
| *C & M & K* | 0.006 | 0.0021 | 0.0059 |
| *C & Y & K* | 0.009 | 0.0206 | 0.0150 |
| *M & Y & K* | 0.014 | 0.0201 | 0.0239 |
| *C & M & Y & K* | 0.006 | 0.0007 | 0.0009 |

**Uppgift 3.2)**
Now, compare column 1, 2 and 3 in this table. Are Demichel's equations a good model of the reality? Does it work reasonably well even when misregistration occurs?

Yes it works fine, it is a good model for reality though it does not work as well when misregistration's occur.

**Uppgift 3.3)**
What would have happened in case of misregistration if all the four printing colors had had the same screen angle? Would Demichel's equation be applicable? Why not?

Demichel's equation would not be applicable since certain patterns are more likely to occur such as the rosette pattern.

## 4) Color Adjustment in CIELAB

**Uppgift 4.1)**
Why do the images seem to be inverted?

The images seem inverted since they are CYNK images. Since computers use additive colors instead of negative which CYMK use. As an example, the parts in image K (black) which light up are the parts of the image which are either red, green or blue. The opposite is true for the black parts of the images with them containing either cyan, magenta or yellow, for the most part yellow in this case.

## Uppgift 4.2)

Insert the image corresponding to L+20 here: (ok to scale down the image)

Insert the image corresponding to L-20 here: (ok to scale down the image)

What attribute (among lightness, contrast, hue, and saturation) has been changed.

Since the L value is changed, the value representing the “lightness” it is the lightness which is changed.

## Uppgift 4.3)

Insert the image when you change the sign of **a*** here: (ok to scale down the image)

Insert the image when you set **a*=0** here: (ok to scale down the image)

Did you expect the results? (answer by looking at Fig. 1.5 in the theory document to see what the a-axis represents).

The results where -a was used were expected since it was pretty easy to imagine changing the green parts of the image to red. a = 0 was a little harder to imagine but it was still expected since we imagined all of the red and green parts being removed.

What attribute (among lightness, contrast, hue, and saturation) of the color do we change when switching sign of **a*** or **b***?

It is the hue which is changed when we switch the sign of a* or b*.

## Uppgift 4.4)

Insert the image when you multiply **a*** and **b*** by 0.5 here: (ok to scale down the image)

Insert the image when you multiply **a*** and **b*** by 3 here: (ok to scale down the image)

What attribute (among lightness, contrast, hue, and saturation) of the color do we change when scaling **a*** and **b***?

Since we scale the values it is the saturation which is changed.

## 5) Light sources, CIEXYZ and CIELAB

## Uppgift 5.1)

XYZ values for CIED65:
X= 95,0437
Y= 100,0000
Z= 108,8818

XYZ values for Tungsten60W:
X= 112,9853
Y= 100,0000
Z= 28,5810

XYZ values for plank90k:
X= 97,0578
Y= 100,0000
Z= 141,1759

Insert the figure showing the color of these three light sources here: (ok to scale down the image)

Are the colors of these three light sources what you expected?

Yes, CIED65 is pure white on my screen which makes sense because most computer screens use d65 as white point. Plank90k is close to blue because the colour temperature in kelvin is very high. Tungsten60W is a warm light which often means its yellow i.e., low colour temperature => low kelvin value.

## Uppgift 5.2)

Insert Figure 1 here: (ok to scale down the image)

What light source it seems to have been used in the above figure?

We assume this is Tungsten60W because its more yellow than the other images.

Insert Figure 2 here and specify: (ok to scale down the image)

What light source it seems to have been used in the above figure?

This one is plank90K because its slightly bluer than the other images.

Insert Figure 3 here: (ok to scale down the image)

What light source it seems to have been used in the above figure?

This is CIED65 because it is the remaining one and the middle ground between the other figures. We can observe that the yellow tile (to the left of bottom right) is less yellow than figure 1(Tungsten60W) and more yellow than figure 2(Plank90K).

## Uppgift 5.3)

Why are the color differences between the color of the objects under **Tungsten** and **plank90k** larger than those under the other two pairs of light sources?

Tungsten is more yellowish (lower Kelvin) and Plank90K is bluer (higher temperature). The colour temperature is opposites as well as being opposite on the CIELAB spectrum compared to CIED65 which should be around 65K which is daylight (bluish white).

## Uppgift 5.4)

You can see in the plot that all light sources have the same Y-value. What is this value?
It is the lightness of the image and is always 100 when the image is fully lit.

## Uppgift 5.5)

How do the positions of the color (XYZ) of the objects move when the illumination is changed? Do you agree that, when the illumination is changed, we get completely different positions in the XYZ space?

Yes, when the lightness increases Plank90K for example moves from the positive a-axis to the negative. Tungsten is bunched up with low lightness and spreads apart when the lightness increases.

## Uppgift 5.6)

What is the CIELab values of light sources and why?

Looking at the function 1.13 we can see that L is constant for light sources when translating between XYZ and CIELAB coordinates. In the figure we can see that the CIED65 light source is in the middle at coordinate (0,0,100) (x, y, z).

## Uppgift 5.7)

How do the positions of the color (Lab) of the objects move when the illumination is changed? Do you agree that the position of each object is almost constant independent of the illumination?

We agree that the position is almost constant, just like we mentioned above the position barely changes.

## Uppgift 5.8)

Discuss at least two differences between CIEXYZ and CIELAB.

CIELAB light sources are constant while the same coordinates in CIEXYZ are different. CIEXYZ cant have negative values while CIELAB requires it to show different colours such as green.
The CIELAB model is easier to interpret compared to the projected model of CIEXYZ, since the difference between colours is based on the perceptual difference.

**Glöm inte att spara dokumentet som *.pdf* innan ni lämnar in det på Lisam.**