Foundations of Multimedia technologies Exam + Midterm retake.
2022.05.31.
Please give the answers in the blank space below the questions and on
further additional blank papers *with indicating the name, Neptun ID and the
no. of the given question*!
Total: 100 points 0-40 points: failure (1), 41-55 points: poor (2), 56-70
points: satisfactory (3), 71-85 points: good (4), 86-100 points: excellent (5)

Név: ——————————————————————————————————

Neptun kód: ——————————————————————————————

1. 10 point The RGB $\rightarrow$ XYZ transform matrix for the ITU-709 HDTV system is defined as:

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.4124 & 0.3576 & 0.1805 \\ 0.2126 & 0.7152 & 0.0722 \\ 0.0193 & 0.1192 & 0.9505 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}_{ITU-709}$$

(a) 5 point Calculate the xy chromaticity coordinates of the RGB primaries and the white
point! Mark the location of these points in the horse-shoe diagram below, and illustrate
the gamut of the color space (i.e. the location of the reproducible colors)!
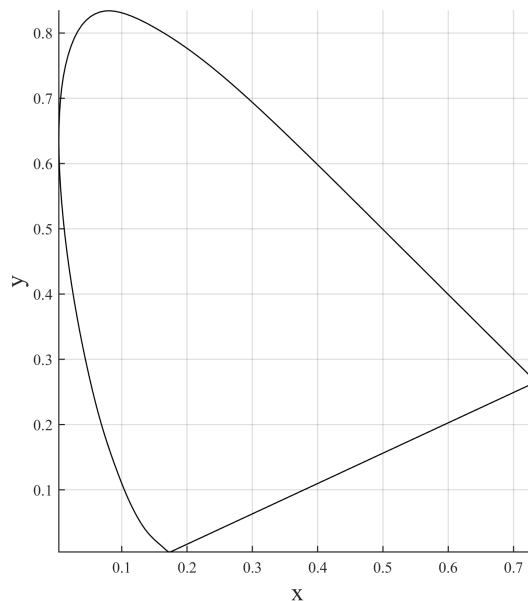
(b) 5 point The ITU-709 RGB coordinates of an arbitrary color C are given as

$$C = \begin{bmatrix} 0 \\ 0.635 \\ 0.635 \end{bmatrix}.$$

Calculate the luminance and the color difference components ($Y, R - Y, B - Y$) of this
color, illustrate its location in the $B - Y, R - Y$ coordinate system and calculate the hue
and saturation of the given color point!

2. $\boxed{\text{10 point}}$ What is chroma-subsampling, why was it introduced and what does the chroma subsampling scheme notation indicate? Describe the chroma subsampling schemes, used in the SD studio standard (ITU-601), in MPEG-1 and in MPEG-2!

3. $\boxed{\text{10 point}}$ Calculate the active bitrate of a 4k UHDTV video stream (number of active pixels: 3840x2160 at frame rate of 60 Hz, with progressive scanning) if the chroma components are subsampled with a sampling scheme 4:2:0 and components are represented in 10 bits/sample!

4. $\boxed{\text{15 point}}$ What is the goal of motion estimation? What is the goal of block matching (the explanation should include illustration)? Name several frequently used block matching algorithms.

5. $\boxed{\text{10 point}}$ What is the general goal of transform coding? What is the optimal transform and name several sub-optimal, fixed base transforms.

6. $\boxed{\text{20 point}}$ Draw the block diagram of an MPEG encoder! Explain the steps of the encoding process if the applied GOP structure is IBBP!

7. $\boxed{\text{10 point}}$ Audio encoding

   - Why do we apply psychoacoustic encoding (mp3, dolby digital, etc.) at all?
   - What kind of error do we introduce to the uncompressed audio by applying a psychoacoustic encoding?
   - Why (or when) isn't it a problem that we introduced this error to our audio signal?

8. $\boxed{\text{3 point}}$ What are the basic axioms of image processing?

9. $\boxed{\text{7 point}}$ List the types of edge detection algorithms and explain their mathematical background!

10. $\boxed{\text{5 point}}$ List the steps of SIFT detector!