

CITY UNIVERSITY OF HONG KONG

Course code & title : EE4115 Audio-Visual Engineering

Session : Semester B 2004/05

Time allowed : Two hours

This paper has FOUR pages (including this cover page).

Instructions to candidates :

- (1) Answer any THREE questions.
 - (2) All questions carry equal marks.
 - (3) Show clearly all essential steps and state all assumptions made.
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Materials, aids & instruments permitted to be used during examination:

City University Approved Electronic Calculator

Special materials

Nil

Answer Any Three questions

Question 1 (33 marks)

A color picture P comprising of the following pair of colors: RED ($R=1.0, G=0.1, B=0.1$) and BLUE ($R=0.2, G=0.2, B=1.0$) is to be packaged into a composite video signal according to the *PAL* standard as shown in figure Q1. The *RGB* to *YUV* transformation is given by

$$Y = 0.3R + 0.59G + 0.11B, U = w_1(B - Y), \text{ and } V = w_2(R - Y).$$

Where w_1 and w_2 are positive real variables within the range $[0,1]$.

1.1. Determine the hue angles, saturation and percentage saturation of the two colors in the picture P for $w_1 = w_2 = 1$. (16 marks)

1.2. Suppose the two weighting factors w_1 and w_2 can be varied, what should be their values so that the minimum amplitude of the combined luminance and chrominance signal of both colors in the composite video signal P is equal to -0.33 (i.e. $V_R = V_B = -0.33$ in figure Q1). (17 marks)

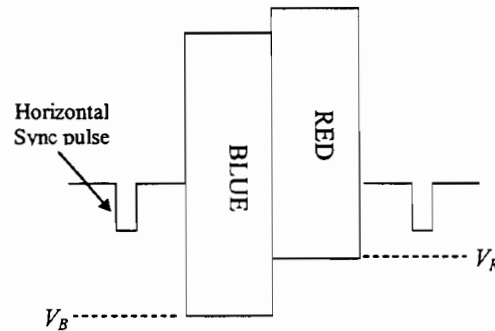


Figure Q1

A line of composite video signal containing the RED and BLUE colors

Question 2 (33 marks)

(a) Describe with one or more diagram(s) why D.C. restoration is required and how to implement it in a *PAL* television. (12 marks)

(b) Describe the structure of the comb filter employed in a *PAL* standard television. With the use of Fourier Transform, derive and sketch the magnitude of the transfer functions that correspond to the sum and difference paths of the comb filter. (21 marks)

Question 3 (33 marks)

- (a) The 4x4 DCT block shown in figure Q3a is to be quantized with the quantization table given in figure Q3b. Assuming that all decimal places will be truncated to zero after quantization, illustrate with diagrams the quantized DCT block, the zigzag scanning path and the result of applying the latter.

(8 marks)

480	-65	81	120
97	5	6	1
-40	5	0	2
8	-6	7	64

Figure Q3a

1	2	8	16
2	16	24	32
8	24	32	48
8	16	48	32

Figure Q3b

- (b) List and illustrate with a simple example the Layer Structure in *MPEG* bit-stream from picture sequence to image blocks.

(15 marks)

- (c) A video sequence is encoded with the *MPEG* standard with the following information:

- Pictures per second: 25
- Slices per picture: 10
- Maximum target bit-rate: 1.2 *Mbps*
- Number of B frames: 10
- Quality of encoded frames
 - *I* frame : Highest.
 - *P* frame: Medium.
 - *B* frame: Lowest.
- Number of bits for representing a slice in the *I*, *P* and *B* frames
 - *I* frame : 10000 bits.
 - *P* frame: 5000 bits.
 - *B* frame: 1000 bits.

Determine the number of *I*, *P*, and *B* frames per second of video sequence so that the best quality on the encoded pictures is attained within the target bit-rate.

(10 marks)

Question 4 (33 marks)

- (a) Explain the principles of the masking effect of the psychoacoustic model employed to conceal quantization noise. Also explain how the bandwidth of each band affects the effectiveness of masking.
(16 marks)
- (b) Explain the concept of audio signal compression in the Adaptive Transform Coding (*ATRAC*) scheme.
(17 marks)

**** END ****