

CITY UNIVERSITY OF HONG KONG

Course code & title : EE4115 Audio-Visual Engineering

Session : Semester B 2005/06

Time allowed : Two hours

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

Instructions to candidates :

- (1) Answer ALL questions.
 - (2) Enter the answers of **Question 1** into Sheet A, and the answers of **Questions 2** and **Questions 3** into the answer book provided.
 - (3) For **Questions 2** and **Questions 3**, show clearly all essential steps and state any assumptions made.
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Materials, aids & instruments permitted to be used during examination:

City University Approved Electronic Calculator

Special materials

Nil

Answer ALL questions

Question 1 (34 marks)

A color bar pattern containing of the following colors is integrated into a *PAL* composite video signal *C*.

Red: (R=1, G=0, B=0) Blue: (R=0, G=0, B=1)
Green: (R=0, G=1, B=0), Yellow: (R=1, G=1, B=0),

The basic *RGB* to *YUV* transform is given by:

$$Y = 0.3R + 0.59G + 0.11B$$

$$U = w_1(B - Y)$$

$$V = w_2(R - Y)$$

where w_1 and w_2 are positive.

- (a) Deduce the weighting factors w_1 and w_2 so that the maximum and minimum amplitude of the composite video signal *C* are 1.33 and -0.33, respectively. (10 marks)

- (b) Adopting the values of w_1 and w_2 obtained in (a), determine the hue angle of each color in the color bar pattern. (8 marks)

- (c) A monochrome video signal has the following specification:

Lines per frame	- 625
Fields per second	- 50
Bandwidth	- 6MHz

Calculate the maximum horizontal resolution of the video signal.

(8 marks)

- (d) If the video signal in part (c) is digitized with 8 bits per pixel, how many bits per second are required to transmit it? (8 marks)

Note: Enter all the answers of **Question 1** into the tables provided in Sheet A.

Question 2 (33 marks)

- (a) The luminance (Y) and chrominance (U, V) samples of a 16×16 macroblock could be packaged in one of the following formats:

(i) 4:4:4 (ii) 4:2:2 (iii) 4:2:0

Assuming that the Y , U and V samples each quantized with 6 bits, compute the number of bits required to represent the macroblock in the each of the above case.

(15 marks)

- (b) A sequence of data:

$[x_0, x_1, \dots, x_7] = [1.5, -2.1, 1.1, -0.04, -0.305, 0.293, -0.63, -0.005]$ is encode

with a linear predictor given by the expression $x_n = \sum_{k=1}^3 a_k x_{n-k}$. Given $\sum_{k=1}^3 a_k = 1$ and assuming no quantization error, and, derive an expression for the coefficients $[a_1, a_2, a_3]$ so that the *Mean Square Prediction Error (MSPE)* is minimized.

(18 marks)

Question 3 (33 marks)

- (a) In a quantization process the quantization error is uniformly distributed over each step size q , determine the mean square quantization error.

(10 marks)

- (b) An input signal $x(n)$ is input into a noise shaping circuit to give an output $y(n)$ as shown in figure Q3. $e(n)$ represents the combination of dithering and quantization noise, H is the noise shaping filter.

Given that the transfer function of H is $e^{-j2\omega}$, determine the total noise power gain of the noise shaper.

(23 marks)

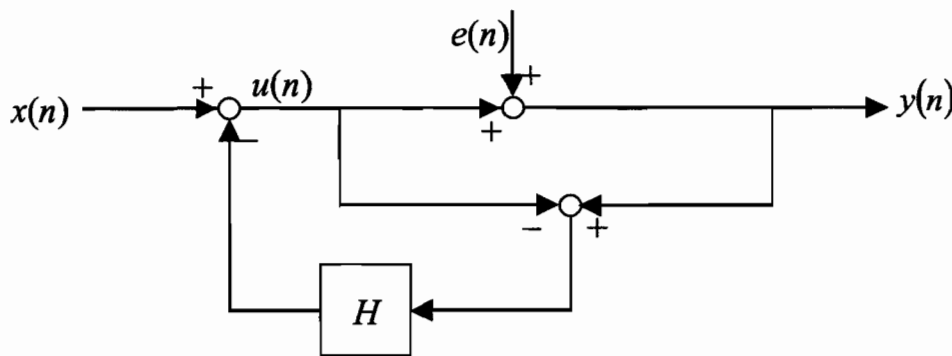


Figure Q3

← END →

Student ID: _____

Seat number: _____

Sheet A

Enter answers of Question 1 in the corresponding tables in this page and submit it together with your answer book.

- (a) Enter the values of the weighting factors w_1 and w_2 into Table 1 below.

Table 1	
w_1	w_2

- (b) Based on the weighting factors in Table 1, enter the saturation and hue angle of the colors Red, Green, Blue, and Yellow in Table 2 below.

Table 2	
Color	Hue angle (in degree)
Red	
Green	
Blue	
Yellow	

- (c) Enter the maximum horizontal resolution (in MHz) into Table 3 below.

Table 3
Maximum horizontal resolution (MHz)

- (d) Enter the number of bits per second required to transmit the monochrome video signal into Table 4 below.

Table 4
Bits per second