

City University of Hong Kong

Course code & title: EE4115 Audio-visual Engineering

Session : Semester B 2012/13

Time allowed : Two hours

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

1. This paper consists of 3 questions.
 2. Answer ALL questions.
 3. Show clearly all essential steps and state any assumptions made.
-

This is a **closed-book** examination

Materials, aids & instruments permitted to be used during examination:

City University Approved Electronic Calculator

Special materials

Nil

Answer ALL questions**Question 1 (34 marks)**

The red (R), green (G), and blue (B) components of a color C are listed below. Each primary color is normalized to the range $[0,1]$.

Color C : $R=1$, $G=0.1$, $B=0.1$.

(a) Deduce the hue angle, saturation, and percentage saturation for the color C .

(8 marks)

(b) 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)

(c) A Comb filter with a Sum output and a Difference output is employed to separate the U and V components of a PAL video signal. Given that the delay line in the Comb filter has a delay time of $T = 64\mu s$, determine and sketch the magnitude transfer functions of the filter. Illustrate in your diagram how a Comb filter can be applied to separate the U and the V components.

(18 marks)

Question 2 (33 marks)

- (a) The resolution and frame rate of a color video signal are 720 (horizontal) x 576 (vertical) pixels and 25 fps, respectively. The signal is decomposed into the YUV domain and the chrominance components are sub-sampled with the 4:2:2 format.

Assuming that the Y , U and V samples are each quantized with 8 bits, compute the bit-rates (per second) required to represent the Y , the U , and the V component of the video signal.

(13 marks)

- (b) The 4x4 DCT block shown in figure Q2a is to be quantized with the quantization table given in figure Q2b. Each entry in the quantization table contains the step size that is used to quantize the corresponding DCT coefficient. Assuming that the quantized value X_q of an integer X is given by

$$X_q = \text{trunc}(X / s),$$

where s is the step size and $\text{trunc}(Z)$ denotes the removal of all decimal places in the quantity Z .

Illustrate with diagrams the quantized DCT block, the zigzag scanning path and the result of applying the latter.

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

Figure Q2a

1	4	8	16
4	8	16	32
8	16	32	48
16	32	48	64

Figure Q2b

(20 marks)

Question 3 (33 marks)

(a) With the use of a block diagram, illustrate the Adaptive Transform Coding (ATRAC) scheme.

(10 marks)

(b) A 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 a filter with the transfer function given by $H(\omega) = \frac{1}{e^{j\omega} - 1}$. Determine the transfer function $\frac{Y(\omega)}{X(\omega)}$ of the noise shaping circuit, and sketch the noise power gain against frequency within the range $0 \leq \omega \leq \pi$ rads/sec.

Note: $Y(\omega)$ and $X(\omega)$ represent the Fourier Transform of $x(n)$ and $y(n)$, respectively

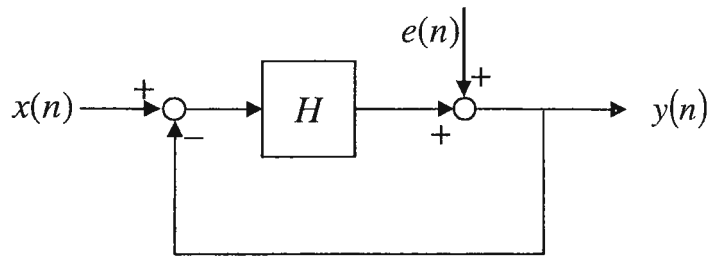


Figure Q3

(23 marks)

← END →