

CITY UNIVERSITY OF HONG KONG

Course code & title	:	EE4115 Audio-Visual Engineering
Session	:	Semester B 2009/10
Time allowed	:	Two hours

Instructions to candidates :

- (1) Answer ALL questions.
 - (2) 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) 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)

- (b) Describe the structure of the comb filter employed in a *PAL* standard television.

(8 marks)

- (c) 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. Illustrate how the comb filter can be employed to extract the chrominance components in a *PAL* video signal.

(18 marks)

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 8 bits, compute the average number of bits-per-pixel required to represent a pixel in the macroblock for each of the above case.

(15 marks)

- (b) The 4×4 *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 $\text{trunc}(Y)$ denotes the truncation of all decimal places in the quantity Y .

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

(18 marks)

Question 3 (33 marks)

(a) A pair-wise pan pot system is designed based on the two loudspeaker configuration shown in Figure Q3. Given the following:

- (i) θ_1 and θ_2 are the angular displacement of the left and the right loudspeakers from the vertical axis, respectively, and $\theta_1 = \theta_2 = 30^\circ$.
- (ii) Gain of the right loudspeaker = 1
- (iii) Gain of the right loudspeaker = 1

Assuming that the gain of each channel decreases linearly with increasing angular displacement from the corresponding loudspeaker, determine the total gain and total power at $\theta_p = 10^\circ$.

(11 marks)

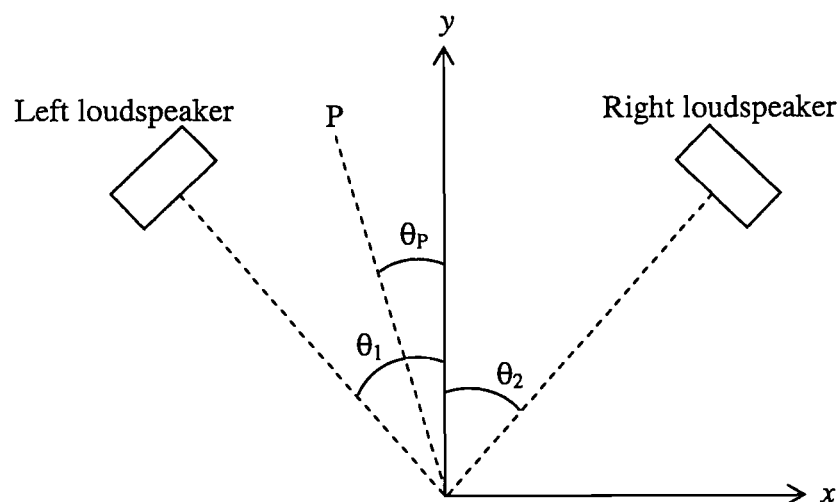


Figure Q3

- (b) An discrete signal $x(n)$ sampled by a sampling frequency f_s 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 $e^{-j\omega}$, determine the transfer function of the noise shaping circuit.

(11 marks)

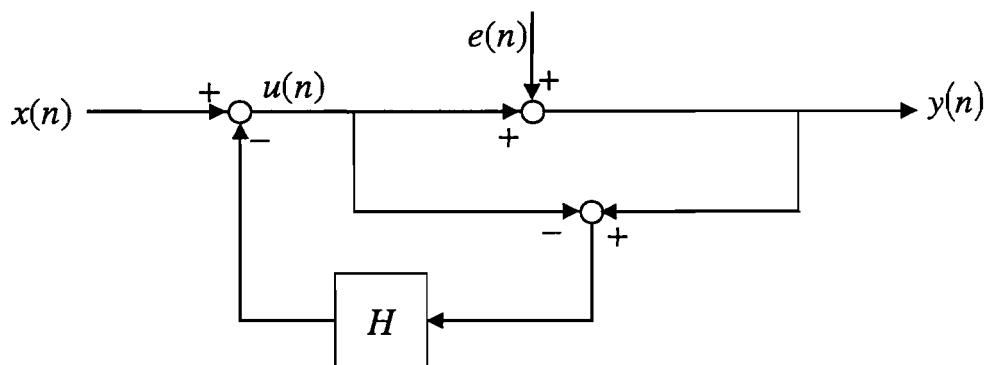


Figure Q3

- (c) Determine the noise power gain of the noise shaping circuit

(11 marks)

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