

CITY UNIVERSITY OF HONG KONG

Course code & title : EE4115 Audiovisual Engineering

Session : Semester B 2011/12

Time allowed : Two hours

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

1. This paper consists of 3 questions.
 2. Answer ALL questions.
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*This is a **closed-book** examination.*

*Candidates are allowed to use the following materials/aids:
Electronic calculators approved by the City University of Hong Kong*

Materials/aids other than those stated above are not permitted. Candidates will be subject to disciplinary action if any unauthorized materials or aids are found on them.

Question 1 (33 marks)

- (a) An interlaced, digital color video signal with each frame comprising of 3 primary color (i.e., the RGB) images has the following specification:

Lines per frame - 625
 Horizontal resolution - 720 pixels
 Fields per second - 50

Calculate the data rate (i.e. number of bits per second) of the above color video signal if it is converted into the YUV representation with a chrominance down-sampling factor of 4:1:1. Number of bits representing a pixel in the Y, U, or V image is 8bit.

(13 marks)

- (b) Sketch the structure of a comb filter, and derive the magnitude of the transfer functions corresponding to the sum and difference paths of the comb filter.

(10 marks)

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

(10 marks)

Question 2 (33 marks)

- (a) The 4x4 DCT block shown in figure Q2a is to be quantized with the quantization table given in figure Q2b. A coefficient of value M is quantized to the level L given by $L = \text{int}(M / sz)$, where sz is the step size, and $\text{int}(X)$ denotes the truncation of all the decimal places associated with X . 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	2	8	16
2	16	24	32
8	24	32	48
8	16	48	32

Figure Q2b

(13 marks)

- (b) A video signal with resolution of 720 (horizontal) x 576 (vertical) is encoded with MPEG2 and reconstructed on three different types of receivers. Each of the latter can only decode MPEG2 encoded video bit-stream with maximum resolution as listed in Table Q2.

Table Q2

Receiver	Maximum horizontal resolution	Maximum vertical resolution
A	720	576
B	360	288
C	180	144

Describe with one or more diagrams how the MPEG2 encoder can be made compatible with the three types of decoders with the use of spatial scalability.

(20 marks)

Question 3 (34 marks)

- (a) In MS recording, a standard cardioid and a figure-eight microphones are used. The directionalities of the standard cardioid and the figure-eight microphones are $\rho = 0.5 + 0.5\cos(\theta)$ and $\rho = \cos(\theta)$, respectively. Describe, with the aid of a diagram, how the pair of microphones should be positioned in the MS recording and sketch the directionality of each microphone. Illustrate mathematically how the audio signals captured with the MS recording should be integrated to give the left and the right channels.

(10 marks)

- (b) A discrete signal $x(n)$ is input into a noise shaping circuit to give an output $y(n)$ as shown in figure Q3.

The term $e(n)$ represents the combination of dithering and quantization noise, and H is the noise shaping filter with a transfer function $e^{-jM\omega}$, where M is an integer multiple of 0.25 within the range $[0.25, 2.0]$.

- (i) Derive the transfer function of the noise shaping circuit. Determine the magnitude of the maximum and the minimum noise power gain of the noise shaping circuit, and the corresponding values of M .

(16 marks)

- (ii) We consider a simplified case that the frequency spectrum $X(\omega)$ of $x(n)$, and the frequency spectrum $E(\omega)$ of $e(n)$ are both equal to 1 (i.e. $X(\omega) = E(\omega) = 1$). Sketch the magnitude of the frequency spectrum of the output signal $y(n)$ between the range $0 \leq \omega \leq \pi$ with the value of M corresponding to the minimum value of the magnitude of the noise power gain.

(8 marks)

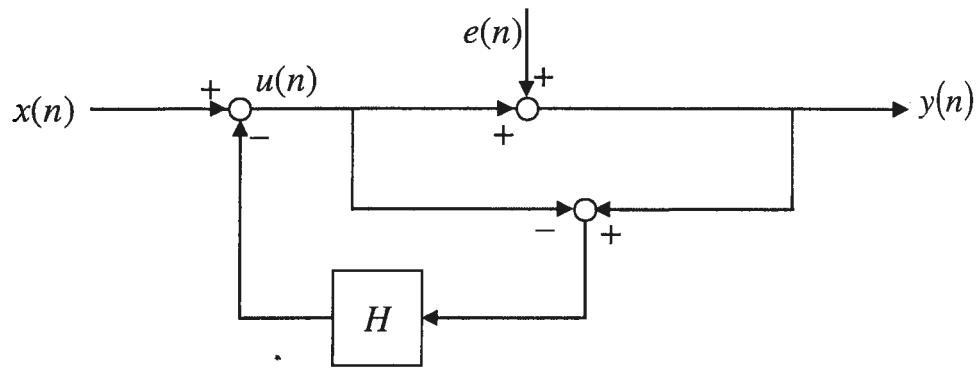


Figure Q3

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