

CITY UNIVERSITY OF HONG KONG

Course code & title : EE4115 Audio-Visual Engineering

Session : Semester B 2006/07

Time allowed : Two hours

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

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 (33 marks)

- (a) Illustrate, with the aid of diagrams, how color video signals are integrated in the frequency spectrum of a *PAL* composite video signal.

(5 marks)

- (b) The color YELLOW color ($R=1, G=1, B=0$) is converted into a *PAL* composite video signal C and transmitted to a television receiver.

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

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

$$U = 0.493(B - Y)$$

$$V = 0.877(R - Y)$$

Suppose a phase error of 5 degrees (i.e. a clockwise rotation of 5 degrees in the phasor formed by the *UV* components) is imposed on the composite video signal C when it is demodulated in the television receiver (before *PAL* compensation is applied), what will be the corresponding change in the color (in *RGB*) of the original YELLOW signal?

(14 marks)

- (c) Illustrate with the use of phasor diagrams how the phase error imposed on the video signal C in part (b) could be compensated in the *PAL* system.

(14 marks)

Question 2 (33 marks)

- (a) A sequence of data $x[n]_{0 \leq n < 8} = [0, 7, 14, 20, 28, 32, 35, 40]$ is encoded with the Linear Predictive Encoder given in Figure Q2.

Based on the Quantizer and De-quantizer defined in Table T2, revise the architecture of the given Linear Predictive Encoder so that $e_{pq}[n]$ can be represented by 2bits.

(11 marks)

- (b) Based on the revised Linear Predictive Encoder obtained in part (a), and given $x_p[n] = \hat{x}[n-1]$ and $x_p[n] = 0$ for $n \leq 0$, determine the output $e_{pq}[n]$ for $0 \leq n < 8$.

(11 marks)

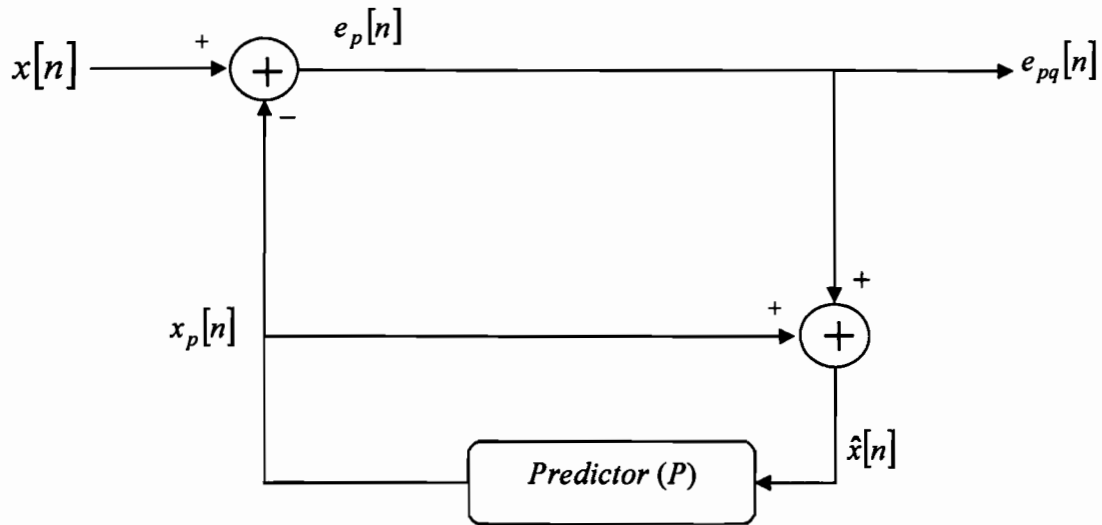


Figure Q2

Table T2 Input and output of Quantizer and De-quantizer

Quantizer $Q(v)$		De-quantizer $Q^{-1}(w)$		
v	$Q(v)$	w	$Q^{-1}(w)$	
0 to 3	0	0	0	
4 to 7	1	1	4	
8 to 11	2	2	8	
12 to 15	3	3	12	

- (c) Draw a diagram of a Linear Predictive Decoder to decode the quantized error $e_{pq}[n]$ for the revised Linear Predictive Encoder obtained in part (a). Determine the Mean Square Error (MSE) of the decoded signal as compared with $x[n]$.

(11 marks)

Question 3 (34 marks)

- (a) A pure sine wave $x(t)$ with peak-to-peak amplitude of $2V$ units is uniformly quantized into M levels with step size $= q$ as shown in Figure Q3a.

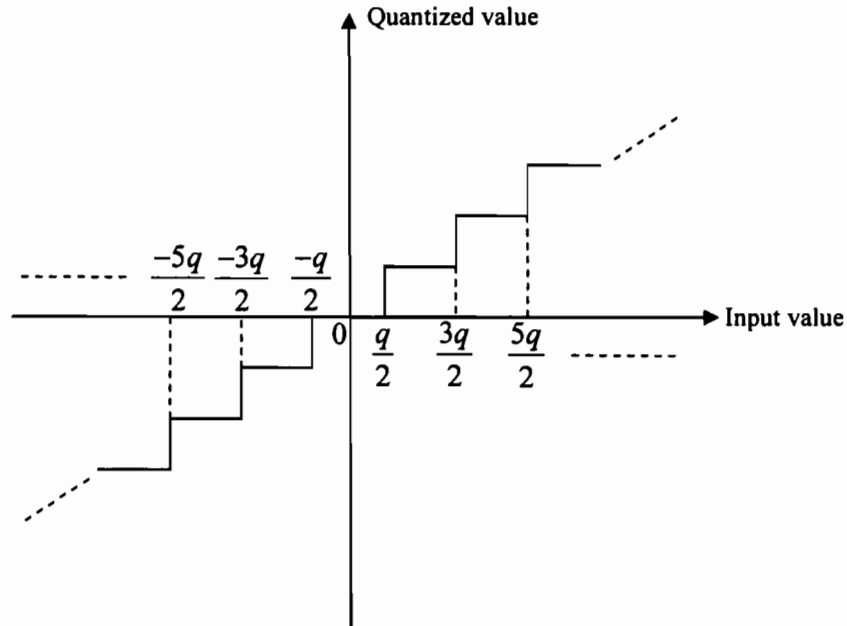


Figure Q3a

Given M is an integer and assuming that the quantization error is uniformly distributed over each step size q . Determine the minimum value of M so that the Signal to Noise Ratio resulted in the quantization of $x(t)$ is above 42dB .

(14 marks)

- (b) Sketch the frequency response curve of a typical human auditory and describe how it can be taken to mask quantization noise. (6 marks)
- (c) In MS microphone recording the side (S) and main (M) channels are recorded by a Bidirectional (a.k.a. Figure-eight) and a Cardioid microphones, respectively as shown in Figure Q3b. The directionality patterns of the two microphones are given as follows.

Bidirectional (a.k.a. Figure-eight): $\rho_{bidirectional} = \cos(\theta)$

Cardioid: $\rho_{cardioid} = 0.5 + 0.5 \cos(\theta)$

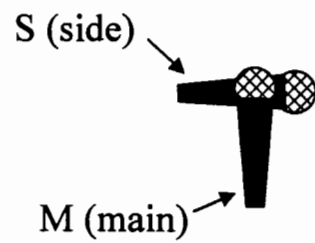


Figure Q3b

Stereo (i.e. left and right) signals can be derived by properly mixing the output signals of the M and S microphones. Explain with the aid of the equivalent directionality patterns resulted from such mixing how stereo recording can be accomplished.

(14 marks)

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