AMERICAN UNIVERSITY OF BEIRUT
FACULTY OF ENGINEERING AND ARCHITECTURE
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

QUIZ # 2

FALL 2003-2004

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TIME: 1.5 HOURS

CLOSED BOOK EXAM

Four sheets of formulas only are permitted

INSTRUCTOR: DR. JEAN J. SAADE

NAME:____________________ **ID #:** ________________

Problem #1

Consider PCM applied to a voice signal whose bandwidth is 4 KHz. The signal is sampled at the Nyquist rate and quantized to 256 levels. Assume that PCM is to be replaced by DM in order to reduce the complexity of the analog-to-digital converter while not requiring a higher transmission bandwidth. Determine, in a general manner, the sampling rate that needs to be used in DM.

Problem # 2

Consider again Problem # 1 and assume that the maximum slope of the voice signal is 100 V/s. Let Δ used in DM technique be equal to 2 volts. Assume now that the main concerns in DM are the avoidance of slope overload distortion and reduction of the required transmission bandwidth. Determine the maximum saving in the transmission bandwidth that can be achieved in this case as compared to the bandwidth needed under the best sampling rate in Problem # 1.

Problem # 3

Consider again Problem # 2 and determine the value of Δ that permits a maximum saving in the transmission bandwidth equal to 50KHz. Assume also that the minimum achievable transmission bandwidth is to be used. Determine and discuss whether the resulting sampling rate in such a case can be validated for use in DM.

Problem # 4

Consider the following signals:

$$m_1(t) = 4\cos(100\pi t) + 2\cos(200\pi t)$$

$$m_2(t) = \frac{4}{100\pi}\cos(100\pi t) + \frac{2}{200\pi}\cos(200\pi t)$$

Determine the signal that requires a smaller Δ in DM in order to avoid slope overload distortion. Explain the reason(s) behind your choice.

Problem # 5

Consider PCM and DPCM in a comparative manner under the same sampling rate. Assume that DPCM reduces the dynamic range of the quantizer input to half of the dynamic range of the quantizer input in PCM. Determine the improvement in signal-to-noise ratio obtained in DPCM over PCM under the use of the same number of quantization levels. That is, let $(SNR)_{DPCM} = k_1 (SNR)_{PCM}$ and determine k_1.

Problem # 6

Consider again Problem # 5 and let the quantizer step-size be the same in both PCM and DPCM. Determine the reduction in the bit rate achieved in DPCM over PCM. That is, let $BR_{DPCM} = BR_{PCM} - k_2$ and determine k_2.

Problem # 7

Consider again the principles in Problems 5 and 6 with the differences that the dynamic range of the quantizer input in DPCM is now equal to one forth of the dynamic range of the quantizer input in PCM and that neither the number of levels nor the step size is the same in DPCM and PCM. It is desired to have k_1 equal to 4. Determine the reduction in the bit rate achieved using DPCM over PCM. That is, k_2.

Problem # 8

In adaptive DPCM, the predictor coefficients are updated on-line and used to generate the predicted value of the message sample. At the receiver, the same predictor is used to regenerate the quantized value of the message. Specify a possible way by which the predictor coefficients at the receiver can be obtained and state any possible disadvantage(s) of the way you specified.

Problem # 9

Let g(t) +W(t) be present at the input of a matched filter receiver with impulse response h(t)=kg(T-t). Let g(t) =rect[(t-T/2)/T] and W(t) be a white noise process with spectral height equal to $N_0/2$. Determine $E[n^2(t)]$, where n(t) is the noise process at the output of the matched filter, without evaluating the integral of the square of the sinc function.

Problem # 10

Consider the binary transmission of base-band data in the form of PNRZ line code with rectangular pulses. Let the channel be ideal and linear and a matched filter receiver be used at the receiving end. Draw the matched filter output for the received pulsed sequence 01101 and show the samples from the matched filter output at t=T, 2T, 3T, 4T and 5T. Determine whether there is or there is no ISI in the matched filter output and clarify the reason(s) for the answer you provided.