Principles of communication systems

EET3202, CUNY City Tech, Fall 2023

Homework #07 (Due on Nov 2)

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Problem 1

An Analog to Digital (A/D) converter quantizes the input into L discrete levels. Calculate the minimum number of bits required for each case.

1) $L = 2$

3) $L = 3$

4) $L = 128$

5) $L = 1023$

6) $L = 4097$

Problem 2

Given a quantization interval of size Δv, a random analog signal can appear at any point in that interval. In last week's lecture we approximated the analog signal with the midpoint of the interval and calculated the mean square error for this approximation. What if we approximate the analog signal with the starting point of the interval instead of the midpoint. What is the mean square error in that case?

Problem 3

Calculate the signal-to-noise ratios (SNR) below in db units.

1) $S_0 = 100\ w,\ N_0 = 1\ w$

2) $S_0 = 50\ w,\ N_0 = 100\ w$

3) $S_0 = 3\ w,\ N_0 = 0.1\ w$

4) $S_0 = N_0 = 2\ w$

$$SNR = \frac{\text{signal power}}{\text{noise power}} = \frac{S_0}{N_0}$$

$$(SNR)_{dB} = 10 \log_{10} (SNR)$$

Problem 4

An audio signal of bandwidth B = 3.4 kHz is transmitted using a binary *companded* PCM with compression factor μ=100. Calculate the number of bits, transmission bandwidth, and the output SNR for a quantizer with L=128 levels. The signal is sampled at the Nyquist rate.

Problem 5

An analog signal band-limited to 7kHz is sampled at a rate 25% higher than its Nyquist rate. The maximum acceptable error in the sample amplitude (quantization error) is 1% of the peak signal amplitude m_p.

a) Calculate the minimum number of bits required for quantization.
b) Calculate the total bit rate (#of bits per second)