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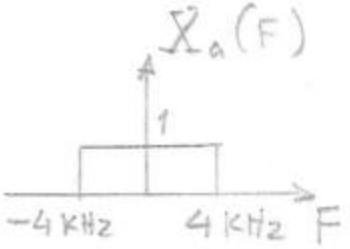
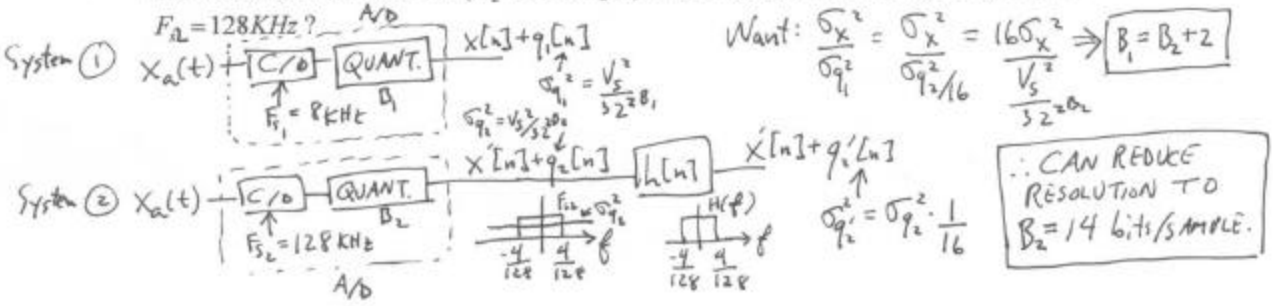
ECE 431H1S, Digital Signal Processing

Quiz 5
January 31, 2005

A signal $x_a(t)$ has the Fourier Transform $X_a(F)$ shown in the figure.



0.7/ The signal is digitized with $F_{s1} = 8KHz$ and resolution $B_1 = 16$ bits/sample. How much can we reduce the resolution (B_2 bits/sample) if we increase the sampling frequency to $F_{s2} = 128KHz$?



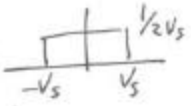
Want: $\frac{\sigma_x^2}{\sigma_{q_1}^2} = \frac{\sigma_x^2}{\sigma_{q_2}^2/16} = \frac{16\sigma_x^2}{V_s^2/3 \cdot 2^{2B_2}} \Rightarrow \boxed{B_1 = B_2 + 2}$

$\sigma_{q_2'}^2 = \sigma_{q_2}^2 \cdot \frac{1}{16}$

$\therefore$ CAN REDUCE RESOLUTION TO $B_2 = 14$ bits/sample.

0.3/ What is the corresponding Signal to Quantization Noise Power Ratio (SQNR) in the two cases?

- will have same SQNR in both cases (by design).
- $SQNR = \frac{\sigma_x^2}{\sigma_{q_1}^2}$, $\sigma_{q_1}^2 = \frac{V_s^2}{3 \cdot 2^{2B_1}}$

CAN ASSUME $x[n]$ IS UNIFORM: $[-V_s, V_s]$: 

$\therefore \sigma_x^2 = \frac{(2V_s)^2}{12} = V_s^2/3$

$\therefore SQNR = 2^{2B_1} = 2^{32}$.

↑ This is the 6 dB/bit rule: $10\log_{10} SQNR = 10\log_{10}(2^{2B_1}) = 20B_1 \log_{10} 2$

$= B_1(6.02)$ dB/.