ECE 351 DSP: Practice Problems 2

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1) Consider the following continuous-time signal $x(t) = F_0 \text{sinc}^2(\frac{\pi t F_0}{2}) \cos(2\pi F_c t)$, where $F_0 = 25$ KHz and $F_c = 87.5$ KHz. Given that your sampling frequency is allowed to drift ± 2 KHz, what is the least possible sampling frequency you can use to allow for perfect reconstruction?
2) Consider designing an A/D converter for some application where the signal $x[n]$ is a wide sense stationary process with the pdf of $x[n]$ for any n being $f(x) = e^{-2|x|}, x \in \mathbb{R}$.
   a) Suppose we want to design the quantizer such that the probability of overload noise is e^{-100}. Find the full scale range of the quantizer.
   b) Next, suppose we want an SQNR of 17.88 dB. What should be the number of bits of the quantizer?
3) Consider a reception system, where a signal and a delayed echo is received. More precisely, let the system be given by $s(t) = x(t) - \alpha x(t - \tau)$, where $|\alpha| < 1$. Suppose we know that the incoming signal is bandlimited to B. Give the sampling frequency F_s, and a discrete-time filter $H(z)$, such that $s(t)$ when sampled at F_s, and processed by $H(z)$, after reconstruction will give the signal $x(t)$.

ANSWERS

1) 68.67 Khz
2) a) 100
   b) 5
3) $F_s = 2B$, $H(z) = \frac{1}{2B(1-\alpha z^{-2B\tau})}$.