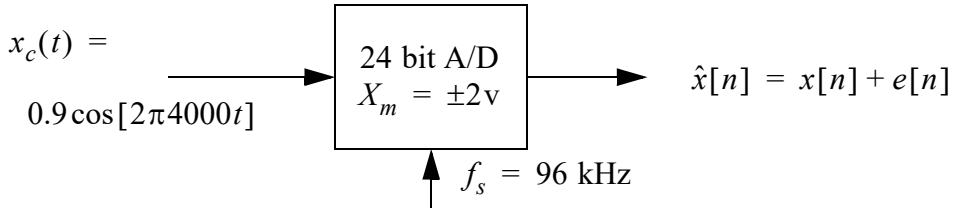
Set #5

Due Tuesday November 11, 2025

Problems:

1. Given the random variable **x** is uniform over (-2, 2) and random variable **y** is uniform over (0, 4). Assume that **x** and **y** are independent. Form the random variable $\mathbf{z} = \mathbf{x} - 2\mathbf{y} + 2$.
   (a) Using the linearity of the expectation operator, find the mean, m_z, of the random variable **z**.
   (b) Similarly, find the variance, σ_z^2, of the random variable **z**.
   (c) Using numpys rand() function generate 100,000 samples each of rv x and y, then form z. Compute the sample mean and sample variance using numpys-functions mean() and var() respectively. How well do these results compare with your answers in parts (a) and (b)?
   (d) Estimate the pdf on rv z using PyLab's hist() function. Use 100 bins to start with. If you use Python the histogram can be scaled to look like a pdf automatically via hist(x,Nbins,normed=True).
2. Text problem 2.98.
3. Consider the following sampling system



   In the above $\hat{x}[n]$ represents the linear noise model equivalent of the A/D output. Thus $x[n]$ is the ideal sampled analog input $x_c(nT)$, and $e[n]$ is the quantization noise.
   (a) Find the variance or signal power of $x[n]$.
   (b) Find the quantization noise power σ_e^2.
   (c) Find the signal-to-quantization noise ratio, SNR_Q, at the A/D output. Your answer should be in dB.
4. Bonus Problem for 10 points: Text problem 4.62.

Heads-up: Exam 2 as Take-Home
Web Posted no later than Friday November 21,
Due by 5:00 PM Tuesday November 28