Computer Graphics
CSE 557, Winter 1997

Study Sheet - Sampling Theory

1. What is the Nyquist frequency for a signal sampled with $T_s = 4$.

2. What is the result of convolving the function $\sum_n c_n \delta(x-n)$ with a box filter ($B(x) = 1$, when $-1/2 \leq x \leq 1/2$, and $B(x) = 0$ otherwise)?

3. Imagine any function $f(x)$ you like and let $F(w)$ be its frequency spectrum. Draw a picture of $F(w)$ and the $F_s(w)$, where $F_s(w)$ is the frequency spectrum of $f(x) comb_{T_s}(x)$.

4. What does it mean to low-pass filter a signal?

5. Suppose that $f(x)$ doesn't contain any frequencies above the Nyquist frequency? How would you reconstruct it from its samples?

6. You can think of aliasing as the confounding of frequencies with one another. The process of analog-to-digital conversion, say of a sound signal, confounds a given frequency with every frequency that differs from it by an integer multiple of the sampling frequency. What frequencies are confounded with a given frequency when alternate samples are thrown away.

7. Suppose that a signal with no frequencies above the Nyquist frequency is sampled, and then reconstructed by convolution with a box filter. What will the the frequency spectrum of the resulting signal look like?

8. Suppose that you start with a signal $f(x)$ such that $F(w) = 0$ for $w \geq 1/2$, and that $f(x)$ is discretely sampled to get $f(j)$ for each integer j. Now suppose you want to scale the image down by a factor of 4. How would you compute the values to put into the frame buffer?

9. What are the pros and cons of stochastic sampling?

10. Prove that reconstructing a signal with a triangle filter of width 2 corresponds to linearly interpolating its samples.