Name: **4-digit student ID:**

DSP Quiz 1 **Spring 04**

1. **A signal x(t) = 3 cos 100 π t is uniformly sampled at the rate of 80 samples per second. Determine the resulting discrete time sequence x (n). You must express the frequency of x (n) in the principal frequency range corresponding to the discrete time domain. (30 points)**

$x(t) = 3\cos 100\pi t$

$F_s = 80$ Hz $\Rightarrow T = \frac{1}{80}$ sec

$x(n) = x(t)\big|_{t=nT} = 3\cos 2\pi \frac{50}{80} n$

$= 3\cos 2\pi \frac{5}{8} n$

$= 3\cos 2\pi \left(1 - \frac{3}{8}\right) n$

$= 3\cos\left(-2\pi \frac{3}{8}\right) n$

$= 3\cos\left(2\pi \frac{3}{8} n\right)$

↑ DT frequency = 3/8 cycles/sample

(Aliasing taken place because $f_s < 2F_N$.

2. A uniform quantizer provides a SQNR of 45 dB. However, the requirement is that SQNR must be at least 52 dB. Will you increase or decrease the number of bits in the quantizer? If so, how many bits? (30 points)

For each additional bit, SQNR is increased by 6 dB. We need to increase SQNR by 7 dB

$\Rightarrow$ Increase the number of bits by 2

3. **A signal x(t) = cos 2π 100 t is uniformly sampled, and produces a discrete time signal x(n) with a frequency (in the principal range) of 0.2 cycles per sample. What is the sampling rate, assuming that it was adequate for reconstructing x(t) from the sampled values? (20 points)**

$F_0 = 100$ Hz Let F_S be the sampling frequency

$$f_0 = \frac{F_0}{F_S} \Longrightarrow F_S = \frac{F_0}{f_0} = \frac{100}{0.2} = \boxed{500\ \text{Hz}}$$

Note: If no information had been provided about the adequacy of the sampling rate for reconstruction, F_S is not unique. An undersampling can also provide an $f_0 = 0.2$ c/s.

4. **Is the signal x(n) = 3 cos(5n + π/6) periodic? Justify your conclusion. If it is periodic, find the period. (20 points)**

This is not periodic

The discrete frequency is 3 rad/sec

$\omega_0 = 3 = 2\pi \cdot \left(\frac{3}{2\pi}\right)$ ← f_0 is NOT rational

You cannot find an N such that

$x(n+N) = x(n)$.