

Homework Assignment VI

Reading Assignment: Kuc Chapter 4

1. Suppose that we would like to sample the following function

$$x(t) = 520 \cos[5200\pi(t + 1)] + 137 \cos(1370\pi t + \frac{\pi}{8}) + 2011 \sin[2012\pi(t - 1)].$$

- (a) Find the sampling rates such that aliasing is guaranteed to be avoided. What is the corresponding sampling period?
- (b) If the highest frequency component is removed from $x(t)$, what is now the Nyquist sampling rate and sampling period?
2. Consider the following sampling scheme of the pure sinusoid $x(t) = \sin(6\pi At)$: sampling points are placed at all positive peaks, negative peaks, and all zero-crossings.
- (a) What is the sampling rate in this case (as a function of A)?
- (b) How far apart in time are the samples in this case?
3. The audio signal in a telephone line has been band-limited to a maximum frequency of 3 kHz.
- (a) Determine the sampling rate at which the A/D converter must sample the signal in order to capture an accurate record of it.
- (b) Determine the time-interval spacing between digital samples if
- we use Nyquist sampling rate as in Part (a)
 - we use 50% oversampling, that is the sampling rate is 50% higher than Nyquist rate
 - we use 50% undersampling, that is the sampling rate is 50% lower than Nyquist rate.
- (c) Suppose that the A/D converter uses 16 bits (2 bytes) to store each output digital sample. Determine the amount of memory required to store 10 seconds of speech for each of the following 3 cases:
- we use Nyquist sampling rate as in Part (a)
 - we use 50% oversampling, that is the sampling rate is 50% higher than Nyquist rate
 - we use 50% undersampling, that is the sampling rate is 50% lower than Nyquist rate.
- (d) What is the corresponding communication bit-rate in kbps (kilo-bits per second) in each of the three cases above?

Due date: **October 31** in class