Solution of ECE 316 Test 2 S06

1. A signal $x(t) = 4\cos(200\pi t) - 7\sin(200\pi t)$ is sampled at its Nyquist rate with one of the samples occurring at time $t = 0$. If an attempt is made to reconstruct ths signal from these samples by ideal sinc-function interpolation what signal will actually be created by this interpolation process?

Reconstructed Signal is $x(t) = 4\cos(200\pi t)$

The sine part of the signal is sampled only at zero crossings and is therefore not represented in the samples. Only the cosine part shows up.

2. A DT signal is passed through a DT lowpass filter with frequency response $H(F) = \text{rect}(8.5F) * \text{comb}(F)$. If every *N*th point of the filter's output signal is sampled what is the maximum numerical value of *N* for which all the information in the original DT signal is preserved? Maximum value of $N = 8$

The highest frequency in the signal from the filter is $F = 1/17$. Twice that value is $F = 2/17$. So the time between samples must be chosen so that $1/N > 2/17$. That implies that $N < 17/2$. Since *N* must be an integer, the maximum value for *N* is 8.

3. A bandlimited periodic CT signal is sampled at twice its Nyquist rate over exactly one fundamental period at $f_s = 220$ Hz with the first sample occurring at $t = 0$ and the samples are $\{1, -2, -4, 6, 3, 5, 9, 7\}$.

(a) (2 pts) What is the numerical maximum frequency at which the CT signal could have any signal power? $f_{\max} = 55$ Hz

Nyquist rate is 110. Therefore highest frequency cannot be greater than 55 Hz.

(b) (3 pts) What is the numerical value of the fundamental period T_0 of the CT signal? $T_0 = 0.0364$ seconds

Time between samples is 1/220 seconds. There are 8 samples in one fundamental period. Therefore the fundamental period is $8/220 = 0.0364$ seconds.

(c) (5 pts) If sample 1 occurs at time $t = 0$ and the sampling continued indefinitely, what would be the numerical value of sample 317 and at what numerical time would it occur?

Sample 317 = 3 , $t_0 = 1.436$ seconds

Value of sample 317 is the same as the value of sample $317 - 8n$ where *n* is any integer. $317 = 8 \times 39 + 5$. Therefore sample 317 is the same as sample 5 which is 3. If sample 1 occurs at time $t = 0$ that means sample 317 occurs at time $316T_s = 316/220 = 1.436$ seconds.

Solution of ECE 316 Test 2 S06

1. (2 pts) A signal $\mathrm{x}(t) = 4\sin(200\pi t) - 7\cos(200\pi t)$ is sampled at its Nyquist rate with one of the samples occurring at time $t = 0$. If an attempt is made to reconstruct ths signal from these samples by ideal sinc-function interpolation what signal will actually be created by this interpolation process?

Reconstructed Signal is $\mathrm{x}(t) = -7\cos(200\pi t)$

The sine part of the signal is sampled only at zero crossings and is therefore not represented in the samples. Only the cosine part shows up.

2. (5 pts) A DT signal is passed through a DT lowpass filter with frequency response $\mathrm{H}(F) = \mathrm{rect}(6.5F) * \mathrm{comb}(F)$. If every *N*th point of the filter's output signal is sampled what is the numerical maximum value of *N* for which all the information in the original DT signal is preserved? Maximum value of $N = 6$

The highest frequency in the signal from the filter is $F = 1/13$. Twice that value is $F = 2/13$. So the time between samples must be chosen so that $1/N > 2/13$. That implies that $N < 13/2$. Since *N* must be an integer, the maximum value for *N* is 6.

3. A bandlimited periodic CT signal is sampled at twice its Nyquist rate over exactly one fundamental period at $f_s = 280$ Hz with the first sample occurring at $t = 0$ and the samples are $\{7,1,-2,-4,6,3,5,9\}$.

(a) (2 pts) What is the numerical maximum frequency at which the CT signal could have any signal power? $f_{\max} = 70$ Hz

Nyquist rate is 140. Therefore highest frequency cannot be greater than 70 Hz.

(b) (3 pts) What is the numerical value of the fundamental period T_0 of the CT signal? $T_0 = 0.0286$ seconds

Time between samples is 1/280 seconds. There are 8 samples in one fundamental period. Therefore the fundamental period is $8/280 =$ seconds.

(c) (5 pts) If sample 1 occurs at time $t = 0$ and the sampling continued indefinitely, what would be the numerical value of sample 317 and at what numerical time would it occur?

Sample 317 = 6 , $t_0 = 1.1286$ seconds

Value of sample 317 is the same as the value of sample $317 - 8n$ where *n* is any integer. $317 = 8 \times 39 + 5$. Therefore sample 317 is the same as sample 5 which is 6. If sample 1 occurs at time $t = 0$ that means sample 317 occurs at time $316T_s = 316/280 = 1.1286$ seconds.