Solution to ECE Test #1 S05 #1

1. A signal $\mathrm{x}(t) = A\sin(2\pi f_0 t)$ is sampled at a rate f_s with the first sample being taken at time $t = 0$.

(a) If $A = 12$, $f_0 = 5$ and $f_s = 24$, what is the numerical value of the second sample? Value = 11.59

$$\mathrm{x}[n] = 12\sin(10\pi n / 24) = 12\sin(5\pi n / 12)$$

The first sample is $\mathrm{x}[0]$ so the second sample is $\mathrm{x}[1] = 12\sin(5\pi / 12) = 11.59$

(b) If $A = 8$, $f_0 = 3$ and $f_s = 19$, what is the numerical value of the eleventh sample? Value = -3.81

$$\mathrm{x}[n] = 8\sin(6\pi n / 19)$$

The first sample is $\mathrm{x}[0]$ so the eleventh sample is $\mathrm{x}[10] = 8\sin(60\pi / 19) = -3.81$

2. Find the Nyquist rates for these signals. If a signal is not bandlimited just write "infinite".

(a) $\mathrm{x}(t) = \mathrm{u}(t) - \mathrm{u}(t-5)$ Nyquist Rate = Infinite

Time limited signal cannot be bandlimited. Nyquist rate is infinite.

(b) $\mathrm{x}(t) = 18\,\mathrm{sinc}\left(\frac{t-3}{10}\right)$ Nyquist Rate = 1/10 Hz

$\mathrm{X}(f) = 180\,\mathrm{rect}(10f)e^{-j6\pi f}$ Highest frequency is 1/20 Hz. Nyquist rate is 1/10 Hz.

(c) $\mathrm{x}(t) = \begin{cases} 14\cos(200\pi t) & , \ 0 < t < 1 \\ 0 & , \ \text{otherwise} \end{cases}$ Nyquist Rate = Infinite

Time limited signal cannot be bandlimited. Nyquist rate is infinite.

Solution to ECE Test #1 S05 #2

1. A signal $\mathrm{x}(t) = A\sin(2\pi f_0 t)$ is sampled at a rate f_s with the first sample being taken at time $t = 0$.

(a) If $A = 15$, $f_0 = 7$ and $f_s = 24$, what is the numerical value of the second sample? Value = 14.49

$$\mathrm{x}[n] = 15\sin(14\pi n/24) = 15\sin(7\pi n/12)$$

The first sample is $\mathrm{x}[0]$ so the second sample is $\mathrm{x}[1] = 15\sin(7\pi/12) = 14.49$

(b) If $A = 3$, $f_0 = 13$ and $f_s = 32$, what is the numerical value of the tenth sample? Value = -2.49

$$\mathrm{x}[n] = 3\sin(26\pi n/32) = 3\sin(13\pi n/16)$$

The first sample is $\mathrm{x}[0]$ so the tenth sample is $\mathrm{x}[9] = 3\sin(117\pi/16) = -2.49$

2. Find the Nyquist rates for these signals. If a signal is not bandlimited just write "infinite".

(a) $\mathrm{x}(t) = \begin{cases} 14\cos(200\pi t) & , \ 0 < t < 1 \\ 0 & , \ \text{otherwise} \end{cases}$ Nyquist Rate = Infinite

Time limited signal cannot be bandlimited. Nyquist rate is infinite.

(b) $\mathrm{x}(t) = \mathrm{u}(t) - \mathrm{u}(t-5)$ Nyquist Rate = Infinite

Time limited signal cannot be bandlimited. Nyquist rate is infinite.

(c) $\mathrm{x}(t) = 18\,\mathrm{sinc}\left(\frac{t-3}{6}\right)$ Nyquist Rate = 1/6 Hz

$\mathrm{X}(f) = 108\,\mathrm{rect}(6f)e^{-j6\pi f}$ Highest frequency is 1/12 Hz. Nyquist rate is 1/6 Hz.