Solution of ECE 316 Test 1 Su09

1. The signal $x(t) = 4\,\text{tri}(t/4) * \delta_9(t)$ is sampled at a rate of $f_s = 2$ samples/second to form the discrete-time signal $x[n]$. The first sample is taken at time $t = 0$. Find the numerical values of

$$x(t) = 4\sum_{k=-\infty}^{\infty} \text{tri}((t-9k)/4)$$

$$x[n] = 4\sum_{k=-\infty}^{\infty} \text{tri}((nT_s - 9k)/4) = 4\sum_{k=-\infty}^{\infty} \text{tri}((n/2 - 9k)/4) = 4\sum_{k=-\infty}^{\infty} \text{tri}((n - 18k)/8)$$

(a) The second sample $x[1]$

$$x[1] = 4\sum_{k=-\infty}^{\infty} \text{tri}((1-18k)/8) = \cdots + 4\underbrace{\text{tri}(19/8)}_{k=-1\Rightarrow 0} + 4\underbrace{\text{tri}(1/8)}_{k=0\Rightarrow 7/8} + 4\underbrace{\text{tri}(-17/8)}_{k=+1\Rightarrow 0} + \cdots = 28/8 = 7/2 = 3.5$$

(b) The 11th sample

$$x[10] = 4\sum_{k=-\infty}^{\infty} \text{tri}((10-18k)/8) = \cdots + 4\underbrace{\text{tri}(10/8)}_{k=0\Rightarrow 0} + 4\underbrace{\text{tri}(-8/8)}_{k=1\Rightarrow 0} + 4\underbrace{\text{tri}(-26/8)}_{k=2\Rightarrow 0} + \cdots = 0$$

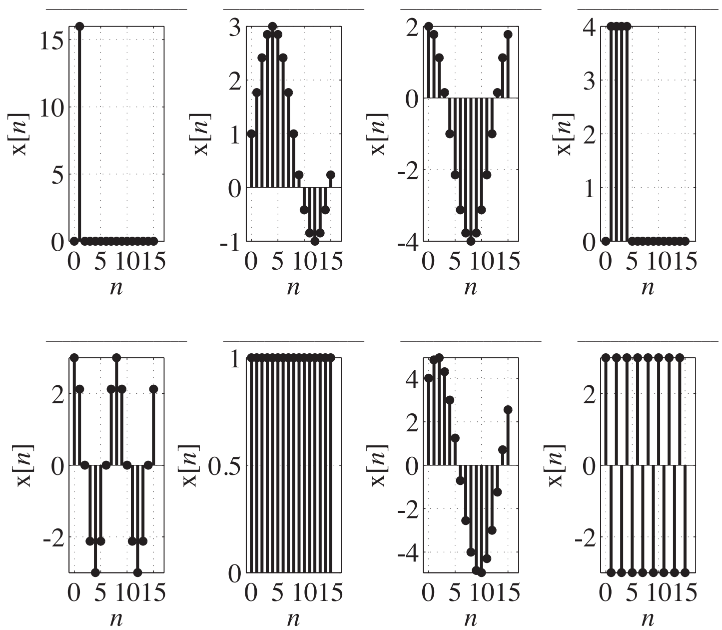
(c) The 14th sample

$$x[13] = 4\sum_{k=-\infty}^{\infty} \text{tri}((13-18k)/8) = \cdots + 4\underbrace{\text{tri}(13/8)}_{k=0\Rightarrow 0} + 4\underbrace{\text{tri}(-5/8)}_{k=1\Rightarrow 3/8} + 4\underbrace{\text{tri}(-23/8)}_{k=2\Rightarrow 0} + \cdots = 12/8 = 3/2 = 1.5$$

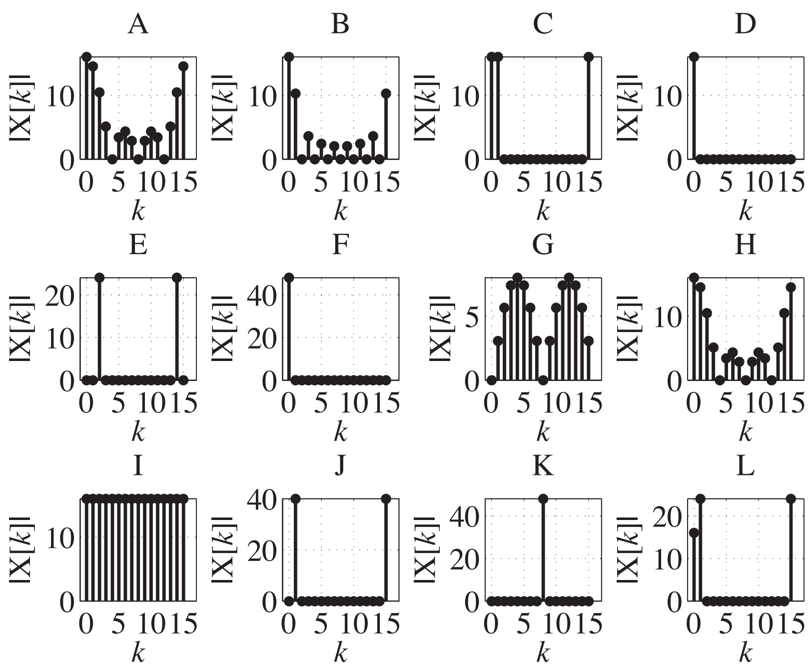
(d) The 392nd sample

$$x[391] = 4\sum_{k=-\infty}^{\infty} \text{tri}((391-18k)/8) = \cdots + 4\underbrace{\text{tri}(13/8)}_{k=21\Rightarrow 0} + 4\underbrace{\text{tri}(-5/8)}_{k=22\Rightarrow 3/8} + 4\underbrace{\text{tri}(-23/8)}_{k=23\Rightarrow 0} + \cdots = 12/8 = 3/2 = 1.5$$

2. Enter in the blank space provided the letter designation of the magnitude DFT graph that corresponds to each discrete-time signal graph.



I	C	L	A or H
E	D	J	K



3. Find the numerical Nyquist rates for these signals. (If a signal is not bandlimited just enter "infinity" or "∞".)

(a) $x(t) = 8\,\text{tri}((t-4)/12)$

$x(t) = 8\,\text{tri}((t-4)/12)$ is timelimited, therefore not bandlimited

(b) $x(t) = 3\,\text{sinc}((t-4)/5)$

$X(f) = 15\,\text{rect}(5f)e^{-j8\pi f} \Rightarrow f_m = 1/10 \Rightarrow f_{Nyq} = 1/5$

(c) $x(t) = -4\sin(30\pi t) + 9\cos(70\pi t)$

$X(f) = -j2[\delta(f+15) - \delta(f-15)] + (9/2)[\delta(f-35) + \delta(f+35)] \Rightarrow f_m = 35 \Rightarrow f_{Nyq} = 70$

(d) $x(t) = 22\sin(30\pi t)\cos(70\pi t)$

$X(f) = j(11/2)[\delta(f+15) - \delta(f-15)] * [\delta(f-35) + \delta(f+35)]$
$X(f) = j(11/2)[\delta(f-20) + \delta(f+50) - \delta(f-50) - \delta(f+20)] \Rightarrow f_m = 50 \Rightarrow f_{Nyq} = 100$

(e) $x(t) = 13e^{-20t}\cos(70\pi t)u(t)$

$X(f) = 13\dfrac{j\omega + 20}{(j\omega + 20)^2 + (70\pi)^2} \Rightarrow$ Not Bandlimited

(f) $x(t) = 11\,\text{sinc}(10t) * \delta_{1/3}(t)$

$X(f) = (11/10)\text{rect}(f/10)(3)\delta_3(f) \Rightarrow f_m = 3 \Rightarrow f_{Nyq} = 6$

Student Identification Number ☐☐☐ - ☐☐ - ☐☐☐☐ (No name please)

By entering my student identification number I affirm that I have neither given nor received help from anyone on this test.

EECS 316 Test 2 Su09

(Closed Book and Notes, Formula Sheet, 8.5 by 11 Sheet, Calculator, 1 hour)

If any question or problem is incomplete, ambiguous or contradictory, explain why. If you are correct you will receive full credit on that question or problem.

1. The signal $\mathrm{x}(t) = 5\,\mathrm{tri}(t/5) * \delta_{11}(t)$ is sampled at a rate of $f_s = 2$ samples/second to form the discrete-time signal $\mathrm{x}[n]$. The first sample is taken at time $t = 0$. Find the numerical values of

(a) (4 pts) The second sample $\mathrm{x}[1]$ ____________

(b) (5 pts) The 11th sample ____________

(c) (5 pts) The 14th sample ____________

(d) (6 pts) The 392nd sample ____________

Solution of ECE 316 Test 1 Su09

1. The signal $\mathrm{x}(t) = 5\,\mathrm{tri}(t/5) * \delta_{11}(t)$ is sampled at a rate of $f_s = 2$ samples/second to form the discrete-time signal $\mathrm{x}[n]$. The first sample is taken at time $t = 0$. Find the numerical values of

$$\mathrm{x}(t) = 5\sum_{k=-\infty}^{\infty} \mathrm{tri}((t-11k)/5)$$

$$\mathrm{x}[n] = 5\sum_{k=-\infty}^{\infty} \mathrm{tri}((nT_s-11k)/5) = 5\sum_{k=-\infty}^{\infty} \mathrm{tri}((n/2-11k)/5) = 5\sum_{k=-\infty}^{\infty} \mathrm{tri}((n-22k)/10)$$

(a) The second sample $\mathrm{x}[1]$

$$\mathrm{x}[1] = 5\sum_{k=-\infty}^{\infty} \mathrm{tri}((1-22k)/10) = \cdots + 5\underbrace{\mathrm{tri}(23/10)}_{k=-1\Rightarrow 0} + 5\underbrace{\mathrm{tri}(1/10)}_{k=0\Rightarrow 9/10} + 5\underbrace{\mathrm{tri}(-21/10)}_{k=+1\Rightarrow 0} + \cdots = 45/10 = 4.5$$

(b) The 11th sample

$$\mathrm{x}[10] = 5\sum_{k=-\infty}^{\infty} \mathrm{tri}((10-22k)/10) = \cdots + 5\underbrace{\mathrm{tri}(10/10)}_{k=0\Rightarrow 0} + 5\underbrace{\mathrm{tri}(-12/10)}_{k=1\Rightarrow 0} + 5\underbrace{\mathrm{tri}(-34/10)}_{k=2\Rightarrow 0} + \cdots = 0$$

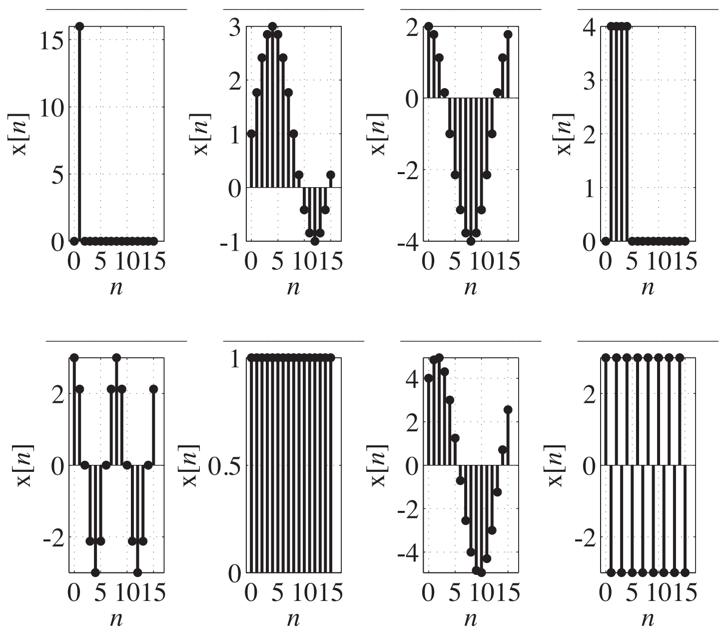
(c) The 14th sample

$$\mathrm{x}[13] = 5\sum_{k=-\infty}^{\infty} \mathrm{tri}((13-22k)/10) = \cdots + 5\underbrace{\mathrm{tri}(13/10)}_{k=0\Rightarrow 0} + 5\underbrace{\mathrm{tri}(-9/10)}_{k=1\Rightarrow 1/10} + 5\underbrace{\mathrm{tri}(-31/10)}_{k=2\Rightarrow 0} + \cdots = 0.5$$

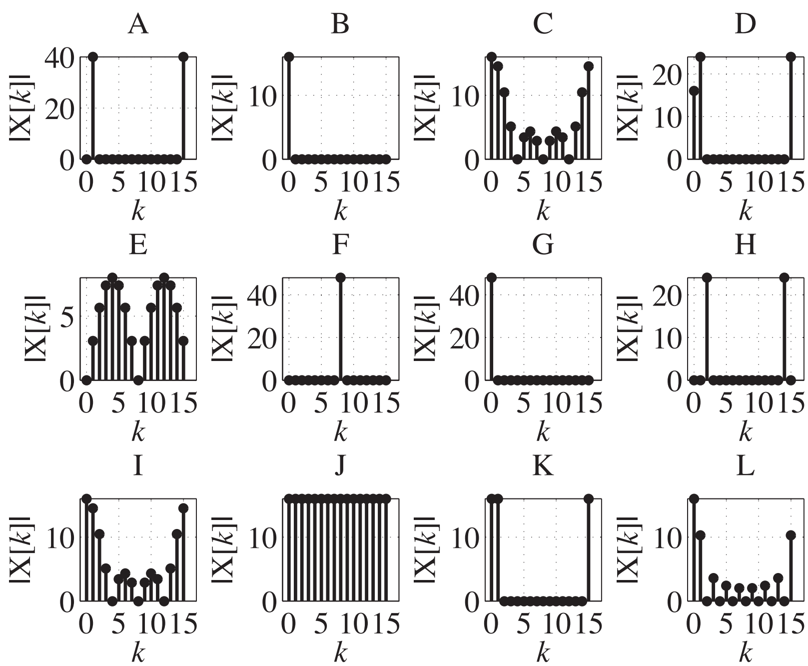
(d) The 392nd sample

$$\mathrm{x}[391] = 5\sum_{k=-\infty}^{\infty} \mathrm{tri}((391-22k)/10) = \cdots + 5\underbrace{\mathrm{tri}(17/10)}_{k=17\Rightarrow 0} + 5\underbrace{\mathrm{tri}(-5/10)}_{k=18\Rightarrow 1/2} + 5\underbrace{\mathrm{tri}(-27/10)}_{k=19\Rightarrow 0} + \cdots = 5/2 = 2.5$$

2. Enter in the blank space provided the letter designation of the magnitude DFT graph that corresponds to each discrete-time signal graph.



J	K	D	I or C
H	B	A	F



3. Find the numerical Nyquist rates for these signals. (If a signal is not bandlimited just enter "infinity" or "∞".)

(a) $\mathrm{x}(t) = 8\,\mathrm{tri}\left(\left(t-4\right)/12\right)$

$\mathrm{x}(t) = 8\,\mathrm{tri}\left(\left(t-4\right)/12\right)$ is timelimited, therefore not bandlimited

(b) $\mathrm{x}(t) = 3\,\mathrm{sinc}\left(\left(t-4\right)/7\right)$

$\mathrm{X}(f) = 21\,\mathrm{rect}(7f)e^{-j8\pi f} \Rightarrow f_m = 1/14 \Rightarrow f_{Nyq} = 1/7$

(c) $\mathrm{x}(t) = -4\sin(30\pi t) + 9\cos(90\pi t)$

$\mathrm{X}(f) = -j2\left[\delta(f+15) - \delta(f-15)\right] + (9/2)\left[\delta(f-45) + \delta(f+45)\right] \Rightarrow f_m = 45 \Rightarrow f_{Nyq} = 90$

(d) $\mathrm{x}(t) = 22\sin(30\pi t)\cos(90\pi t)$

$\mathrm{X}(f) = j(11/2)\left[\delta(f+15) - \delta(f-15)\right] * \left[\delta(f-45) + \delta(f+45)\right]$
$\mathrm{X}(f) = j(11/2)\left[\delta(f-30) + \delta(f+60) - \delta(f-60) - \delta(f+30)\right] \Rightarrow f_m = 60 \Rightarrow f_{Nyq} = 120$

(e) $\mathrm{x}(t) = 13e^{-20t}\cos(70\pi t)\mathrm{u}(t)$

$$\mathrm{X}(f) = 13\frac{j\omega + 20}{(j\omega + 20)^2 + (70\pi)^2} \Rightarrow \text{Not Bandlimited}$$

(f) $\mathrm{x}(t) = 11\,\mathrm{sinc}(16t) * \delta_{1/3}(t)$

$\mathrm{X}(f) = (11/16)\,\mathrm{rect}(f/16)(3)\delta_3(f) \Rightarrow f_m = 6 \Rightarrow f_{Nyq} = 12$

Solution of ECE 316 Test 1 Su09

1. The signal $x(t) = 8\,\mathrm{tri}(t/7) * \delta_{15}(t)$ is sampled at a rate of $f_s = 2$ samples/second to form the discrete-time signal $x[n]$. The first sample is taken at time $t = 0$. Find the numerical values of

$$x(t) = 8\sum_{k=-\infty}^{\infty} \mathrm{tri}((t-15k)/7)$$

$$x[n] = 8\sum_{k=-\infty}^{\infty} \mathrm{tri}((nT_s - 15k)/7) = 8\sum_{k=-\infty}^{\infty} \mathrm{tri}((n/2 - 15k)/7) = 8\sum_{k=-\infty}^{\infty} \mathrm{tri}((n-30k)/14)$$

(a) The second sample $x[1]$

$$x[1] = 8\sum_{k=-\infty}^{\infty} \mathrm{tri}((1-30k)/14) = \cdots + 8\underbrace{\mathrm{tri}(31/14)}_{k=-1\Rightarrow 0} + 8\underbrace{\mathrm{tri}(1/14)}_{k=0\Rightarrow 13/14} + 8\underbrace{\mathrm{tri}(-29/8)}_{k=+1\Rightarrow 0} + \cdots = 104/14 = 7.43$$

(b) The 11th sample

$$x[10] = 8\sum_{k=-\infty}^{\infty} \mathrm{tri}((10-30k)/14) = \cdots + 8\underbrace{\mathrm{tri}(40/14)}_{k=-1\Rightarrow 0} + 8\underbrace{\mathrm{tri}(-10/14)}_{k=0\Rightarrow 4/14} + 8\underbrace{\mathrm{tri}(-20/14)}_{k=1\Rightarrow 0} + \cdots = 16/7 = 2.29$$

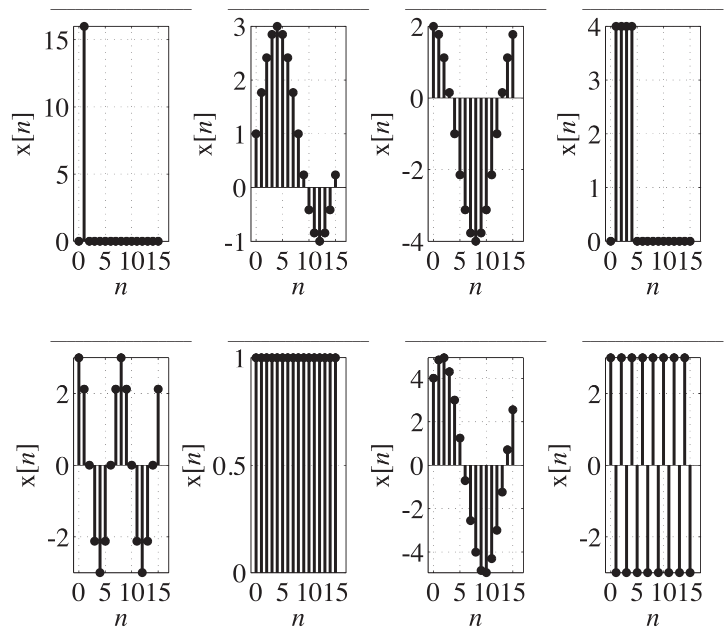
(c) The 14th sample

$$x[13] = 8\sum_{k=-\infty}^{\infty} \mathrm{tri}((13-30k)/14) = \cdots + 8\underbrace{\mathrm{tri}(43/14)}_{k=-1\Rightarrow 0} + 8\underbrace{\mathrm{tri}(13/14)}_{k=0\Rightarrow 1/14} + 8\underbrace{\mathrm{tri}(-17/14)}_{k=1\Rightarrow 0} + \cdots = 8/14 = 0.571$$

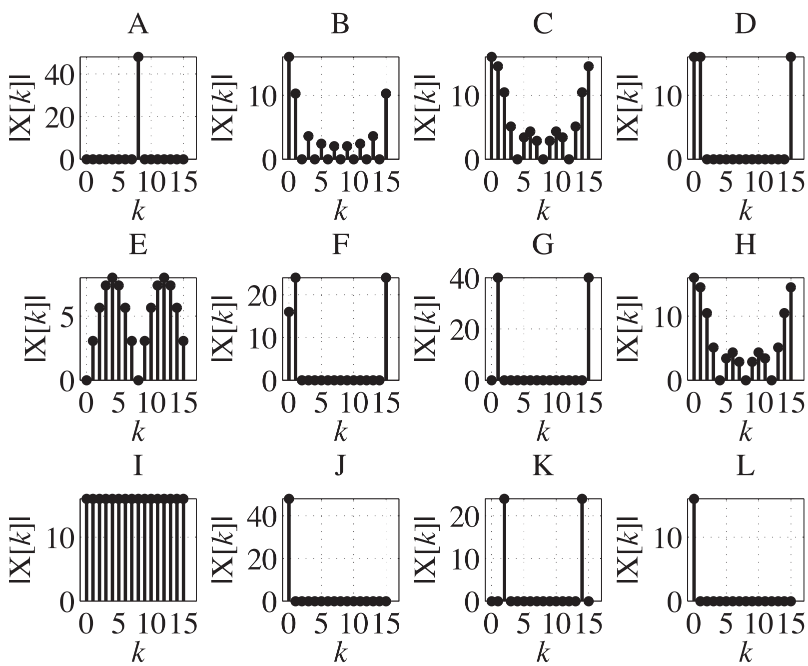
(d) The 392nd sample

$$x[391] = 8\sum_{k=-\infty}^{\infty} \mathrm{tri}((391-30k)/14) = \cdots + 8\underbrace{\mathrm{tri}(31/14)}_{k=12\Rightarrow 0} + 8\underbrace{\mathrm{tri}(1/14)}_{k=13\Rightarrow 13/14} + 8\underbrace{\mathrm{tri}(-29/14)}_{k=14\Rightarrow 0} + \cdots = 104/14 = 7.43$$

2. Enter in the blank space provided the letter designation of the magnitude DFT graph that corresponds to each discrete-time signal graph.



I	D	F	C or H
K	L	G	A



3. Find the numerical Nyquist rates for these signals. (If a signal is not bandlimited just enter "infinity" or "∞".)

(a) $x(t) = 8\,\text{tri}\left((t-4)/12\right)$

$x(t) = 8\,\text{tri}\left((t-4)/12\right)$ is timelimited, therefore not bandlimited

(b) $x(t) = 3\,\text{sinc}\left((t-4)/11\right)$

$X(f) = 33\,\text{rect}(11f)e^{-j8\pi f} \Rightarrow f_m = 1/22 \Rightarrow f_{Nyq} = 1/11$

(c) $x(t) = -4\sin(30\pi t) + 9\cos(110\pi t)$

$X(f) = -j2\left[\delta(f+15) - \delta(f-15)\right] + (9/2)\left[\delta(f-55) + \delta(f+55)\right] \Rightarrow f_m = 55 \Rightarrow f_{Nyq} = 110$

(d) $x(t) = 22\sin(30\pi t)\cos(110\pi t)$

$$X(f) = j(11/2)\left[\delta(f+15) - \delta(f-15)\right] * \left[\delta(f-55) + \delta(f+55)\right]$$
$$X(f) = j(11/2)\left[\delta(f-40) + \delta(f+70) - \delta(f-70) - \delta(f+40)\right] \Rightarrow f_m = 70 \Rightarrow f_{Nyq} = 140$$

(e) $x(t) = 13e^{-20t}\cos(70\pi t)\,u(t)$

$X(f) = 13\dfrac{j\omega + 20}{(j\omega + 20)^2 + (70\pi)^2} \Rightarrow$ Not Bandlimited

(f) $x(t) = 11\,\text{sinc}(20t) * \delta_{1/3}(t)$

$X(f) = (11/20)\,\text{rect}(f/20)(3)\delta_3(f) \Rightarrow f_m = 9 \Rightarrow f_{Nyq} = 18$