ASSIGNED: Jan. 15, 2015. **READ:** Chap. 1 and Sects. 2.1-2.3 on basic signals.
DUE DATE: Jan. 22, 2015. **TOPICS:** Periodic sinusoids, sampling and aliasing.

Please $\boxed{\text{box}}$ your answers. Show your work. Turn in all Matlab plots and Matlab code.

[25] 1. Compute the periods of the following signals. Show your work.

[05] (a) $x(t)=7\cos(0.16\pi t+2)$. [5] (b) $x[n]=7\cos(0.16\pi n+2)$. [5] (c) $x[n]=7\cos(0.16n+2)$.
[10] (d) $x[n]=3\cos(0.16\pi n+1)+4\cos(0.15\pi n+2)$. HINT: Use least common multiple.

[15] 2. $x(t)=\cos(2\pi 30t)+\cos(2\pi 70t+\pi)$ is sampled at $100\frac{\text{SAMPLE}}{\text{SECOND}}$.
[05] (a) Show algebraically (by substituting $t=\frac{n}{100}$) that the sampled signal is 0!
[10] (b) Plot the spectrum of the sampled signal. Show all of the components cancel.

[15] 3. $x(t)=\sin(2\pi 30t)+\sin(2\pi 70t)$ is sampled at $100\frac{\text{SAMPLE}}{\text{SECOND}}$.
[05] (a) Show algebraically (by substituting $t=\frac{n}{100}$) that the sampled signal is 0!
[10] (b) Plot the spectrum of the sampled signal. Show all of the components cancel.

[12] 4. For complex numbers z_1=3–j4 and z_2=12+j5, compute: 4@[3 each]
(a) z_1 (b) z_2 (c) $(z_1+z_2^*)^2$. (d) $\frac{z_1}{z_2}$ **all in polar form**.
Why? You will be doing MANY manipulations of complex numbers in EECS 451!

[12] 5. Put each of the following in the form $A\cos(\omega t+\theta)$: 4@[3 each]
(a) $4e^{jt}+4e^{-jt}$. (b) $-je^{j2t}+je^{-j2t}$. (c) $je^{j(3t+1)}-je^{-j(3t+1)}$. (d) $(3+j4)e^{j6t}+(3-j4)e^{-j6t}$.
Why? You will be doing MANY manipulations of complex exponentials in EECS 451!

[21] 6. Download the file `p1.mat` from the web site www.eecs.umich.edu/~aey/eecs451.html by right-clicking on 'p1' and selecting 'Save Target As' in Matlab's current directory. At Matlab prompt >>, type `load p1.mat` to get a row vector `X` of a sampled signal. I will use `this font` to represent Matlab commands to be typed at the prompt >>.

[07] (a) Listen to `X`: Type `soundsc(X,24000)`. Describe it. Use earplugs in a CAEN lab.
`X` was sampled at $24000\frac{\text{SAMPLE}}{\text{SECOND}}$. Plot its spectrum (`F`=frequency in Hertz):
`N=length(X)/2;F=linspace(0,12000,N);FX=abs(fft(X));plot(F,FX(1:N))`
0 Hz is at the left end; the Nyquist rate of 12000 Hz is at the right end.

[07] (b) Type `Y=X(1:2:end)`. Repeat (a) using `Y` instead of `X` throughout.
This is the same as sampling at $12000\frac{\text{SAMPLE}}{\text{SECOND}}$, since every other sample is deleted.
Now 0 Hz is at the left end; the Nyquist rate of 6000 Hz is at the right end.

[07] (c) Type `Z=X(1:4:end)`. Repeat (a) using `Z` instead of `X` throughout.
This is the same as sampling at $6000\frac{\text{SAMPLE}}{\text{SECOND}}$, since 3 out of 4 samples are deleted.
Now 0 Hz is at the left end; the Nyquist rate of 3000 Hz is at the right end.
Slow `Z` down by listening to `soundsc(Z,6000)`. This reconstructs at $6000\frac{\text{SAMPLE}}{\text{SECOND}}$.
(c) is an example of what *aliasing* sounds like. Include your plots in your write-up.
Print all three spectrum plots on one page using `subplot`. What happend in (c)?

"Luck is what happens when preparation meets opportunity"-Darrell Royal.