Homework 1

ECE 2200
Fall 2015
Due 09/04/2015 at 12pm

The following problems are from the textbook (*Signal Processing First* by McClellan, Schafer, and Yoder)

Problem 1

P-2.3 Make a carefully labeled sketch for each of the following functions.

(a) Sketch $\cos\theta$ for values of θ in the range $0 \leq \theta \leq 6\pi$.

(b) Sketch $\cos(0.2\pi t)$ for values of t such that three periods of the function are shown.

(c) Sketch $\cos(2\pi t/T_0)$ for values of t such that three periods of the function are shown. Label the horizontal axis in terms of the parameter T_0.

(d) Sketch $\cos(2\pi t/T_0 + \pi/2)$ for values of t such that three periods of the function are shown.

Problem 2

P-2.7 Simplify the following expressions:

(a) $3e^{j\pi/3} + 4e^{-j\pi/6}$

(b) $(\sqrt{3} - j3)^{10}$

(c) $(\sqrt{3} - j3)^{-1}$

(d) $(\sqrt{3} - j3)^{1/3}$

(e) $\Re e\left\{je^{-j\pi/3}\right\}$

Give the answers in *both* Cartesian form $(x + jy)$ and polar form $(re^{j\theta})$.

Problem 3

P-2.9 Define $x(t)$ as

$$x(t) = 2\sin(\omega_0 t + 45^\circ) + \cos(\omega_0 t)$$

(a) Express $x(t)$ in the form $x(t) = A\cos(\omega_0 t + \phi)$.

(b) Assume that $\omega_0 = 5\pi$. Make a plot of $x(t)$ over the range $-1 \leq t \leq 2$. How many periods are included in the plot?

(c) Find a complex-valued signal $z(t)$ such that $x(t) = \Re e\{z(t)\}$.

Problem 4

P-2.10 Define $x(t)$ as

$$x(t) = 5\cos(\omega t) + 5\cos(\omega t + 120^\circ) + 5\cos(\omega t - 120^\circ)$$

Simplify $x(t)$ into the standard sinusoidal form: $x(t) = A\cos(\omega t + \phi)$. Use phasors to do the algebra, but also provide a plot of the vectors representing each of the three phasors.

Problem 5

P-2.15 Define $x(t)$ as

$$x(t) = 5\cos(\omega t + \tfrac{1}{3}\pi) + 7\cos(\omega t - \tfrac{5}{4}\pi) + 3\cos(\omega t)$$

Express $x(t)$ in the form $x(t) = A\cos(\omega t + \phi)$. Use complex phasor manipulations to obtain the answer. Explain your answer by giving a phasor diagram.

Problem 6

P-2.19 Solve the following equation for M and ψ. Obtain *all* possible answers. Use the phasor method, and provide a geometrical diagram to explain the answer.

$$5\cos(\omega_0 t) = M\cos(\omega_0 t - \pi/6) + 5\cos(\omega_0 t + \psi)$$

Hint: Describe the figure in the z-plane given by the set $\{z : z = 5e^{j\psi} - 5\}$ where $0 \le \psi \le 2\pi$.

Additional problem(s):

Problem 7

The following is a computational problem. We strongly suggest you use Matlab.
Hint: Use the command "sound". Learn how to use this function by typing "help sound".

a) Generate a single tone with frequency $f_0 = 100\,\text{Hz}$ for a total of 2 seconds using the standard sampling rate of CDs $f_s = 44.1\,\text{kHz}$. Play the sound. Do you hear what you expect?
In increments of 100 Hz, increase f_0 until you reach $f_0 = 2000\,\text{Hz}$. Play the sound each time. Does each sound (total of 20) make sense? What kind of pattern do you notice as you increase f_0?

b) Generate a single tone with frequency $f_0 = 1\,\text{kHz}$ for a total of 2 seconds using the sampling rates given in the table below. Listen to the tone each time and estimate its frequency (fill out the table). Based on your results, describe what is happening. Is there a frequency below (or above) which the tone is not changing. If yes, find this critical frequency. Finally, which tones (frequencies) from part a) show up in your table (if any)? Which do not (if any) ?

f_s	3000	2900	2800	2700	2600	2500	2400	2300	2200	2100	2000	1900
f_0(est)												
f_s	1800	1700	1600	1500	1400	1300	1200	1100	1000			
f_0(est)												