**Tune-Up Tuesday for September 11, 2018**

(a) Copy, paste and run the Matlab code from slide 1-14 to generate the cosine signal *x*(*t*) = cos(2 *f*0 *t*) with *f*0 = 440 Hz and play it as an audio signal for 3 seconds at the sampling rate of *f*s = 8000 Hz:

**% (a) ‘A’ note on Western scale in fourth octave (A4) @ 440 Hz**

**% See https://en.wikipedia.org/wiki/Piano\_key\_frequencies**

**f0 = 440; % note ‘A4’**

**fs = 8000; % sampling rate**

**Ts = 1/fs; % sampling time**

**t = 0 : Ts : 3; % 3 seconds**

**x = cos(2\*pi\*f0\*t);**

(b) Add to the code in (a) to generate a new signal *y*(*t*) = cos(2 *f*0 *t*) cos(2 *f*1 *t*) with *f*1 = 110 Hz by using the same sampling rate of *f*s = 8000 Hz.

**% (b) Multiply cosine @ 440 Hz and cosine @ 110 Hz**

**% Modified the code from the left side of lecture slide 3-3.**

**f1 = 110;**

**x1 = cos(2\*pi\*f1\*t);**

**y = x .\* x1;**

(c) Add to the code in (b) to playing *y*(*t*) as an audio signal.

**% (c) Play y(t) at sampling (playback) rate of 8000 Hz.**

**% I hear two notes/tones.**

**% The product can be written as a sum of two cosines.**

**% Using the result from lecture slide 3-2,**

**% y(t) = 0.5 cos(2 pi 330 t) + 0.5 cos(2 pi 550 t)**

**% Tones at 330 Hz (E4) and 550 Hz (C#5) are harmonics of 110 Hz**

**% See https://en.wikipedia.org/wiki/Piano\_key\_frequencies**

**sound(y, fs);**

(d) Copy and paste your code for (c) into the Tune-up Tuesday #2 page on Canvas.

**% Although not asked, we plot one period of y(t) in Matlab.**

**% Modified the code from the right side of lecture slide 3-3**

**% The product of two sinusoids produces frequencies f0+f1 and f0-f1**

**ffund = gcd(f0+f1, f0-f1);**

**Tfund = 1/ffund;**

**n = round(Tfund / Ts); % Tfund / Ts isn’t an integer.**

**plot( t(1:n), y(1:n) );**

