% In-Lecture Assignment #1 on Sept. 14, 2020

% For an intro to spectrograms, please see slides 1-14 to 1-20 of [CommonSignalsInMatlab.pptx]

% Write the MATLAB code for the following:

% (a) Generate a chirp signal $x[n] = 0.1 \cos(\omega_0 n + \pi (0.7\text{x}10^{-5}) n^2)$ where
% ω_0 is the discrete-time frequency corresponding to 220 Hz for n = 0, 1, …, 24000.

```
fs = 8000;          % Samples/s
n = 0 : 3*fs;       % There are fs samples in 1s
f0 = 220;           % A3 (A note at 220 Hz in third octave on Western scale)
w0 = 2*pi*f0/fs;
x = 0.1*cos(w0*n + pi*(0.7*10^(-5))*(n.^2));
```

% (b) Plot the spectrogram $x[n]$ with f_s = 8000 Hz.
% Spectrogram divides a long signal in smaller blocks for frequency analysis.
% The fourth argument specifies the blockSize in samples.
% -- The first block has blockSize samples starting at index zero. The Fourier series
% is computed, and the magnitude of the Fourier transform is plotted in the first column.
% -- The second block has blockSize samples starting at index (blockSize – overlap),
% and the magnitude of the Fourier series is plotted in the second column, etc.
% The second argument indicates that a Hamming window is applied to each block to
% reduce artifacts due to period extension of the block via the Fourier series
% Frequency resolution is 2π/blockSize. Time resolution is shift = blockSize – overlap.

```
blockSize = 1024;
overlap = 512;        % 50% overlap of samples in adjacent blocks of samples
spectrogram(x, blockSize, overlap, blockSize, fs, 'yaxis');
```

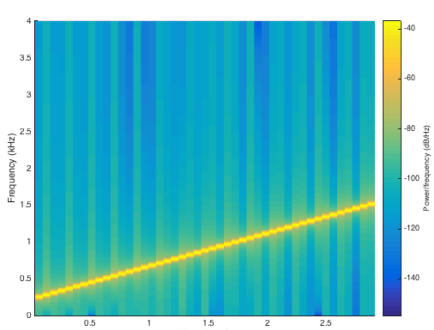
% (c) Turn the volume down to a low setting on your computer and
% Play the audio signal using f_s = 8000 Hz.

```
soundsc(x, fs);
```

% (d) Using MATLAB comments, describe what you hear.

% In part (b), the spectrogram shows that the principal frequency is increasing
% linearly with time from 220 Hz to about 1530 Hz. See plots at bottom of the page.

% In part (c), the principal frequency (note) increases in frequency vs. time.
% Three students said that it sounds like [Doppler effect], e.g. when a car blarring its
% horn travels at constant speed towards a stationary observer and the observer
% hears an increasing frequency.



blockSize = 1024;
overlap = 512;
Hamming window

blockSize = 1024;
overlap = 1023;
Hamming window