

Instructions for Running the MATLAB Wav Analysis Program

1.) Login to any one of the Windows 7 computers machines in 6105 ESB) with Username = **Your_NetId**, PW = **Your_PW**, Domain = **UofI**

2.) Use the mouse to double-click on the **MATLAB** shortcut on the desktop.

3.) In the MATLAB command window (the RHS window) type in:

```
>> cd wav_analysis <cr> {i.e. change directory to the  
C:\desktop\work\wav_analysis folder}
```

then type in:

```
>> ls <cr> {to show the files in this sub-folder}
```

4.) You will see a MATLAB file in this folder called **wav_analysis.m** - to run this program, type in {in the MATLAB command (RHS) window}:

```
>> wav_analysis <cr>
```

5.) A small pop-up menu-type window titled "wav_analysis" {Waveform Analysis} window will appear on the screen. Use the mouse to click on the "File" pull-down menu. Currently, there are two file options: a.) "Open WAV" and b.) "Open Test Waveform".

a.) "Open WAV" opens a *.wav format file - which is user specified. Currently, there exist many *.wav files located in the C:\MATLAB6p5p1\work\sounds sub-folder which you can analyze. Note that any new *.wav files created during the semester should be put in new sub-folders in this area!

If you click on the "Open WAV" option, a new pop-up window titled "Wav file to edit" will appear, the file location of which is defaulted to the \wav_analysis subfolder. Thus, you want to go *up* one folder - to the \sounds sub-folder, then *down* into the \sounds sub-folder, and then *down again* into any one of the sub-sub-folders containing *.wav files. Choose any *.wav file there by using the mouse - click on it once to select it in the "Wav file to edit:" window, then click on the "Open" button in the "Wav file to edit:" window.

The selected *.wav file will then be read in by the wav_analysis program. A pop-up window titled "Figure No. 1" will appear, showing the sound waveforms (amplitude vs. time) on both left and right (i.e. stereo) audio information channels.

A small pop-up window, titled "Which channel" will appear, asking you to select either the Left or the Right channel for analysis. Look at the waveform data shown on "Figure No. 1", look carefully at the vertical scales of both left and right channels of the sound data and then decide/choose which channel (left or right) you want to analyze. Then click on either the "Left" or "Right" button in the small "Which channel?" window. Usually the left channel is the one that has sound data recorded on it.

b.) "Open Test Waveform" - there are currently two test waveform choices, available in a sub-pulldown menu of this option - triangle or square wave. Choose one of these, if you are interested in seeing the analysis of one of these waveforms.

6.) Next, in the "wav_analysis" window, click on the "Clip Waveform" button. Figure No. 1 window will re-appear, this time with the previously selected left or right audio

channel information (amplitude vs. time) displayed on the plot. A graphics cursor will also appear. Use the graphics cursor to click (once only!) on the start and stop times on the displayed waveform in order to tell the wav_analysis program which segment of the sound data file it is to analyze. Note also that you can double-click on the blue task-bar to expand this window (or any other window) to full screen if you so desire.

Immediately after you have used the graphics cursor to click on the start & stop times, the program then re-draws Fig. No. 1 amplitude vs. time for just the selected region in time.

7.) Next, again in the "wav_analysis" window, click on the "Show 3D Surface" button to display the 3D color plot of the log of the amplitude² vs. frequency vs. time. Another small pop-up window will appear, titled "Plot3d..." You can change the lower and upper bounds of the Frequency Axis Scaling from its default values (e.g. 0-5500 Hz). You can also change the Minimum Amplitude displayed from its default value of 0.01. If any of these values are changed, the 3D plot can then be replotted by clicking on the "Replot" button in this small pop-up window.

8) Going back to the main "wav_analysis" menu window, you can make the window with the 3-D log(Amplitude²)-frequency-time surface disappear by clicking on the "Hide 3D Surface" button.

9.) Next, you can look at the harmonic content of the selected waveform by clicking on the "Choose Harmonics" button of the main "wav_analysis" menu window. A new (big) window titled "get_harms" will pop-up which displays a *semi-log* plot of amplitude² vs. frequency. Use the graphics cursor to select several (e.g. up to 5) of the largest harmonics. To do this correctly for each harmonic, one uses the graphics cursor to click *once* on the low-side of a big harmonic and then click *once* on the high side of a big harmonic. One does this for each harmonic one wishes to analyse. As one uses the graphics cursor to select the low-high frequency analysis window for each harmonic, vertical green bands will appear at these boundaries for each selected harmonic, and the corresponding numerical values of the frequencies of the selected harmonic ranges will appear in a small window on the LHS of this plot.

If a mistake is made in selecting harmonics with the graphics cursor, this entry of low-high frequencies can be deleted by selecting the unwanted entry in the "Harmonic Ranges" window of the LHS of the plot. When one does this, two vertical red lines appear on the plot, indicating the low-high frequency pair that will be removed. Click on the "Remove Selected" button to remove this low-high frequency pair. When completely satisfied with selection of harmonics, use the graphics cursor to click on the "Done" button at the bottom of the big "get_harms" window.

If the overall frequency range of interest is desired to be changed from its default values, this can also be accomplished by changing the upper/lower bounds of the "Frequency Axis Scaling" window on the LHS of the big "get_harms" window.

10.) Next, go back to the main "wav_analysis" menu and click on the "Analyze" button. As soon as this button is clicked on, you will first hear the (selected portion of the) sound file, and then in succession, each of the sounds associated with each harmonic on the

computer's speakers. When analysis of the sound has been completed, a small window "Done Fitting Harmonics" pops up - click on OK.

11.) Next, in the main "wav_analysis" menu click on the "Show Harmonic Fits" button to see how the frequency and phase of each of the harmonics that were selected, vary with time - Figures 3 & 4. You can hide these harmonic fit plots from the main "wav_analysis" menu.

12.) Next, click on "Show Aggregate Plots" to view aggregate plots of the fitted frequencies vs. time, absolute and relative phases vs. time for the selected harmonics, a phasor plot of the harmonics, and a bar chart showing the relative strengths of the harmonics, normalized to the fundamental.

13.) After you become familiar with using this program, after selecting the input *.wav file for analysis, you can just click on the last "Run/Show All" button in the main "wav_analysis" menu to do all of the above, automatically. You will still have to select/choose left/right channels of the *.wav file and select/choose the start/stop times on the selected channel of data, and select/choose the harmonics. This option of the main "Wav_analysis" just automatically proceeds from one menu item after another in the main "wav_analysis" menu.

14.) You can save plots and analysis results by going to the pull-down file menu and selecting any one of the following options:

- a.) Save Data to XML – writes out sound analysis data to a file in XML format
- b.) Write Shown Figures to EPS – exports shown figures to a file in EPS format
- c.) Write Shown Figures to PNG – exports shown figures to a file in PNG format
- d.) Write Filtered Sounds – writes out *.wav files for each selected harmonic
- e.) Save All – writes out all data and saves figures in EPS/PNG format

15.) When sound analysis is completed, exit the MATLAB wav_analysis program by clicking on the "X" in the small red box in the upper right-hand corner of the MATLAB main analysis window; do similarly for all of the remaining figures and other pop-up windows on the computer screen.

16.) Backup/copy any/all sound wav_analysis files that you have created to the appropriate \\engr-file-03\phyinst\APL Courses\PHYCS498PM\Common\MATLAB_Analyses folder/subfolder backup area – double click on the **New P406POM Backup** icon on the desktop of the computer to get to this area. Note that no backups of the files on any of the PC's in 6105 ESB are made!

17.) Then logout from the computer.