Laboratory 3 - Signals and Systems Workbench

Worksheet

1. On the next page, apply the vocal tract frequency response to the source spectrum to derive the ouput spectrum.

   The "x" marks on the input spectrum show the level of each sinewave component of the complex periodic source. Levels are shown in dB relative to a reference level of 0 dB (taken here to be the level of the highest-amplitude component of the source). The two spectra are marked up with horizontal lines at 1 dB intervals.

   Measure the level of each input component, and estimate the level of each output component to the nearest dB. Draw the output spectrum in the bottom panel.

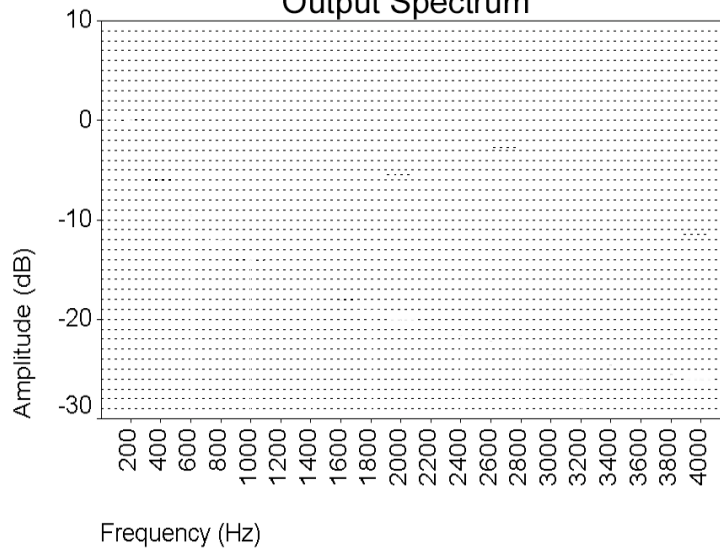   The vocal tract response shown here approximates that for the first 3 formants of a neutral vowel.

Source spectrum

Amplitude (dB)

Frequency (Hz)

Vocal tract frequency response

Oral frequency response (dB)

Frequency (Hz)

Output Spectrum

Amplitude (dB)
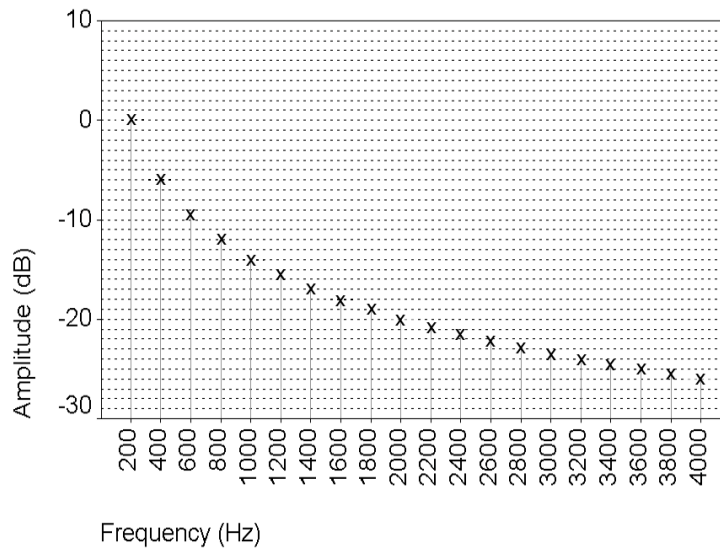
Frequency (Hz)
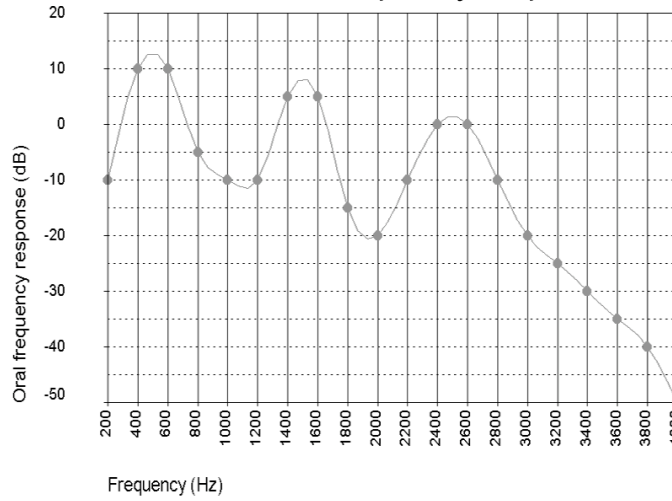
1. Each member of the group should analyse their own utterance of the phrase:

   'Gene had thirty-four smart boots'

   The Esection program allows you to record the sentence, to display a wide-band spectrogram and to calculate spectral cross-sections.

   Zoom in to the complete utterance and print it out for your file. Annotate your printed spectrogram with the word positions (or with a phonetic transcription).

2. Use the cross-section display to measure the first three formant frequencies for the following vowels in the sentence:

Vowel	F1 (Hz)	F2 (Hz)	F3 (Hz)
[i] in 'Gene'			
[æ] in 'had'			
[ɜ] in 'thir'			
[ɔ] in 'four'			
[ɑ] in 'smart'			
[u] in 'boots'			

3. Plot your vowels and those of your group on an F1-F2 graph. Plot F1 going top to bottom on the *right* side of the paper, and F2 going right to left across the *top* of the paper. Allow a range of 200-1000Hz for F1, and 500-3000Hz for F2.

4. Plot your vowels on the class F1-F2 diagram. If you are *male* plot your vowels in *blue*, if you are *female*, plot your vowels in *red*.

5. See if you can see any consistency within your group for F3 values. What can you infer from this about the importance of F3 for vowel perception?

   _____

   _____

   _____

6.   (If you have time) record and measure spectrograms of some simple diphthongs such as

> [aɪ]   in 'buy'
> [ɔɪ]   in 'boy'
> [əʊ]   in '(rain)bow'

See if the formant frequencies match up to those of the monophthongal vowels you measured in 2.

Concluding Remarks

The class F1-F2 diagram will probably show a large amount of variation in the measured formant frequencies for each vowel. In general there are many causes for the differences we observe in our instrumental analyses of "identical" phonological vowels. Below, write down as many reasons for these observed differences as you can.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____