SPECTRUM CHAPTER 3

Hearing Test 5:59

https://www.youtube.com/watch?v=H-iCZElJ8m0&feature=youtu.be

Mine Attenuates at about 8000Hz
BW = 40 -8000 HZ best at 300-7000 Hz

Time Domain vs. Frequency Domain, What's the Difference? – What the RF (S01E02)

40,639 views •Feb 13, 2018 4:41

https://www.youtube.com/watch?v=I2T3OYNqhyA&feature=youtu.be

He shows the Oscilloscope and Spectrum Analyzer results for sinusoids.

VIDEOS For 2/3/2021

The Spectrum: Representing Signals as a Function of Frequency

https://www.youtube.com/watch?v=xh5pLY3f6H8

53,079 views •Aug 23, 2018 11:32 VanVeen

Generally, the same as our Chapter 2 and Introduction to Chapter 3 lectures.

Acoustics for Musicians and Artists

http://msp.ucsd.edu/syllabi/170.13f/course-notes/node3.html

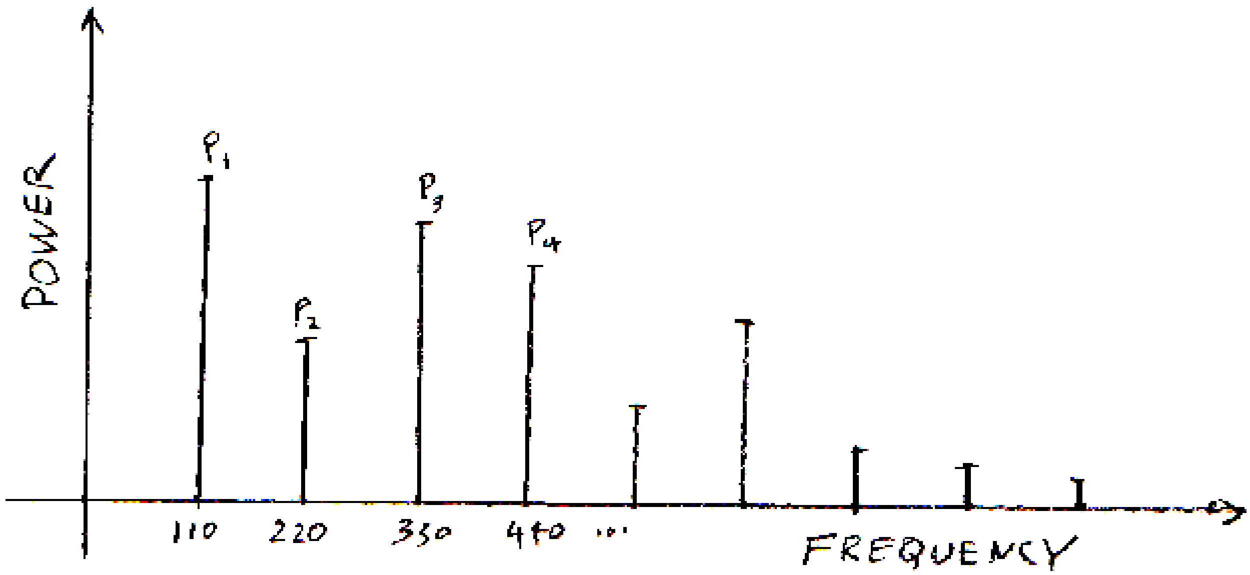
Music 170/ICAM 103 course notes DRAFT: November 24, 2014 **M**iller Puckette

This is just Chapter 3:

SOUND EXAMPLE: Recording of a pulse, repeated 110 times per second; 5 second duration.

3.1.1 Discrete Spectra

Suppose for example we either have, or want to generate, a periodic signal whose fundamental frequency is 110 Hz. In section 2.2 we claimed (without proof and with some waving of hands about continuity requirements) that such a signal could be written as a sum of sinusoids with frequencies 110, 220, 330, and so on. Each of these components has its own amplitude and initial phase. In situations where we don't care about the phase, we can represent the signal's Fourier series graphically, for example like this:



Here the numbers P_1, ..., represent the average power of the sinusoidal components. (Alternatively we could specify their peak amplitudes since the two are related

by $P = a^2/2$. I chose power instead of amplitude to make clear the parallel between this and the following picture.)

Such a spectrum is called *discrete* because all the power is concentrated on a discrete set, that is, a set containing finite number of points per unit of frequency. The example here is furthermore a ***harmonic*** **spectrum**, meaning that the frequencies where there is power are all multiples of a fundamental frequency that is within the audible frequency range (in this case, 110 Hz). This is the spectrum of a complex **periodic** tone (section 2.2).

A discrete spectrum could also describe a complex inharmonic tone, in which case we say that the spectrum, too, is inharmonic.

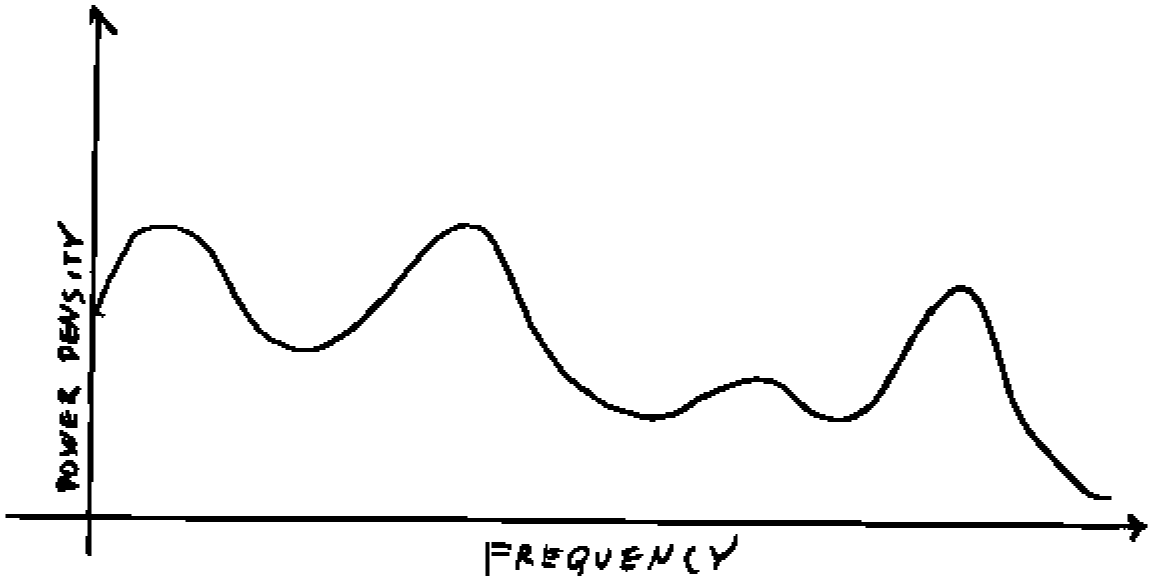
3.4 The Inner Ear

The active element of human hearing is the part of the human body that translates mechanical motion into nerve activation. This is a tiny, coiled, worm-shaped device in the inner ear called the *cochlea*.

(I worked at Rice and Medical Center on a Cochlea Implant using filters. What was interesting is that many frequency bands could be dropped and the patient could still understand.)

3_1_2 CONTINUOUS SPECTRA

Signals or recordings that occur in nature never have discrete spectra; their spectra are *continuous* functions of frequency. A signal's continuous power spectrum might look as shown:



Continuous power spectra can be (and perhaps usually are) measurements of a real signal over a finite period of time (for a signal) or a finite number of sample points (for a recording). A continuous power spectrum has a physical meaning: the area under the curve over a range of frequencies (say from f_1 to f_2 is the total average power of the signal between those two frequencies. The area under the entire curve (from zero frequency to the highest possible one) is the total average power of the signal.

To put this another way: the continuous power spectrum describes how the average power of the signal is distributed over frequencies. Its units are power per frequency (for instance, watts per Hz.).

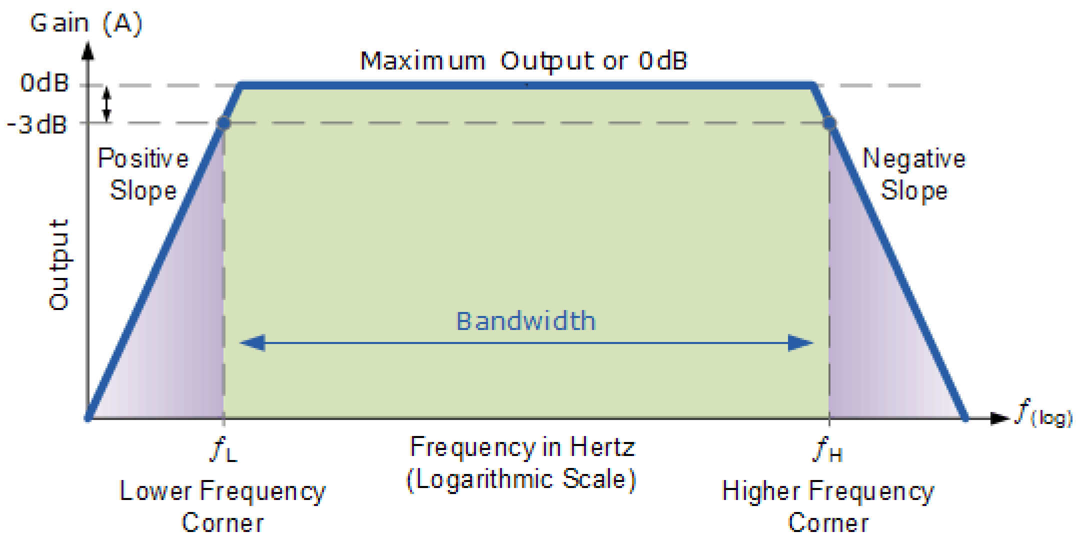
BANDWIDTH

https://www.electronics-tutorials.ws/amplifier/frequency-response.html

(May be slow to start article.)

Graphical representations of frequency response curves are called **Bode Plots** and as such Bode plots are generally said to be a semi-logarithmic graphs because one scale (x-axis) is logarithmic and the other (y-axis) is linear (log-lin plot) as shown.

Frequency Response Curve



So the bandwidth is simply given as:

$$\text{Bandwidth, (BW)} = f_H - f_L$$

The decibel, (dB) which is 1/10th of a bel (B), is a common non-linear unit for measuring gain and is defined as $20\log_{10}(A)$ where A is the decimal gain, being plotted on the y-axis. Zero decibels, (0dB) corresponds to a magnitude function of unity giving the maximum output. In other words, 0dB occurs when $Vout = Vin$ as there is no attenuation at this frequency level and is given as:

$$\frac{V_{OUT}}{V_{IN}} = 1, \quad \therefore\ 20\log(1) = 0\text{dB}$$

Remember   If $y = 10^x$ $\log_{10} y = x$

Decibels Example No1

If an electronic system produces a 24mV output voltage when a 12mV signal is applied, calculate the decibel value of the systems output voltage. Log(2) = 0.301

$$A_V \, dB = 20\log_{10}(A_V)$$

$$A_V \, dB = 20\log_{10}\left(\frac{V_{OUT}}{V_{IN}}\right) = 20\log_{10}\left(\frac{24mV}{12mV}\right) = 20\log_{10}(2)$$

$$\therefore \; A_V \, dB = 6\,dB$$
