

# **MUS 6: Electronic Music**

Section Lecture 2

*Wednesday, October 14, 2020*

# Lecture Outline

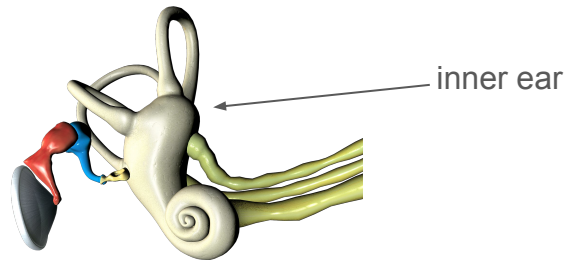
1. Announcements
2. General Information
3. Fourier Theory
4. Homework 1 (Ableton Live Basics)

# Announcements

- **Homework Assignment #1 is DUE by Friday, [Oct 23](#) at 11:59 pm**
- We'll finish our in-class discussion of the assignment today. If you still need more guidance, please email me with questions. You can also set up a time to meet with me individually over Zoom.

# General Information: Student Question

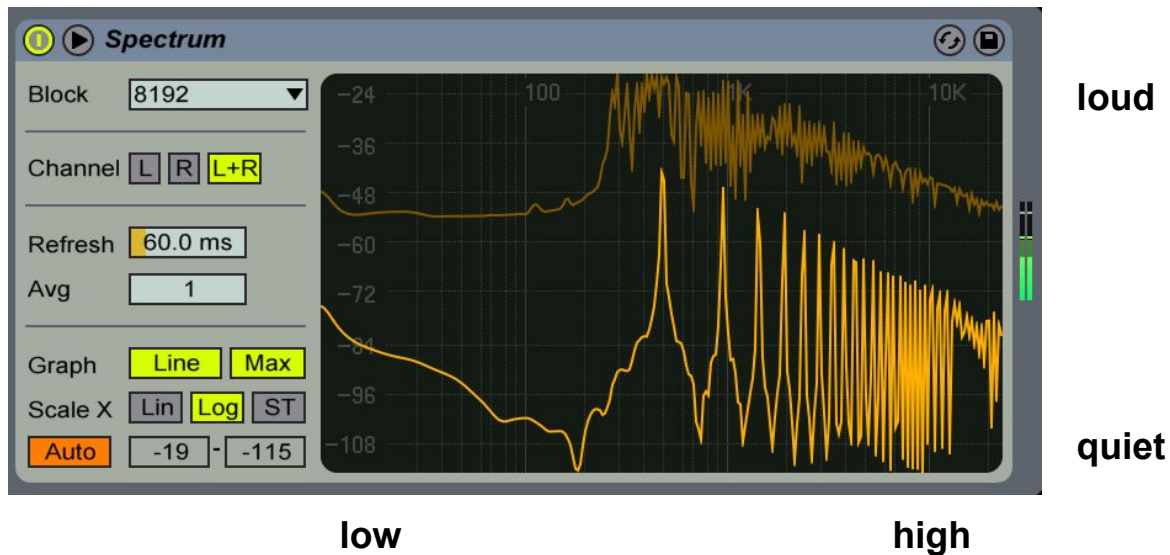
- What is an otoacoustic emission (OAE)?
  - An OAE is a sound generated within the inner ear
  - It is emitted either spontaneously or by stimulation. A spontaneous OAE ranges in frequency from 500 - 4,500 Hz (cycles per second). The frequency of a stimulated OAE is determined by the method being used to stimulate the OAE; depending on the method, several different pitches can be stimulated.



# Fourier Theory

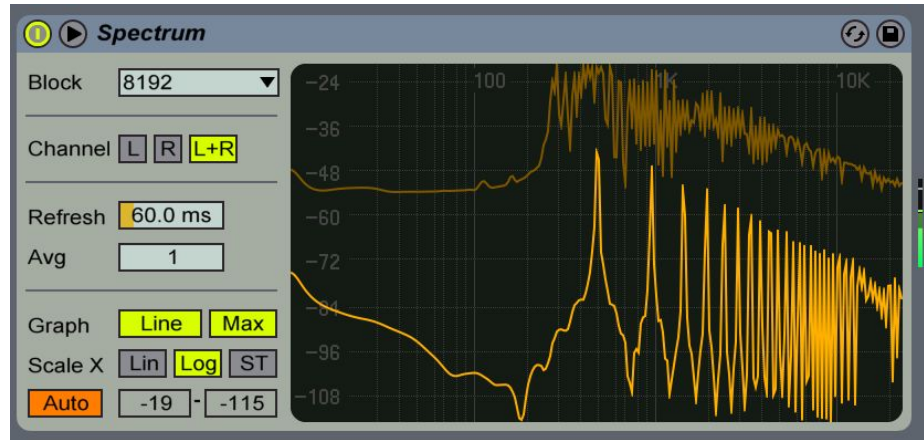
# Fourier Theory: Spectrum analyzer

- The spectrum analyzer shows us a spectrum (i.e. a distribution of frequencies). The x-axis is in frequency and the y-axis is in loudness.

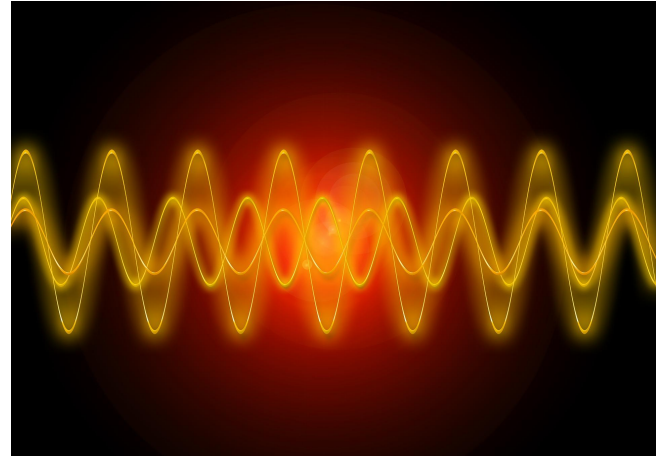
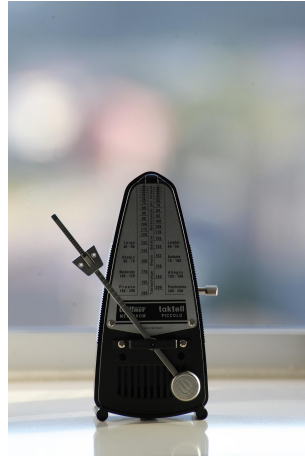
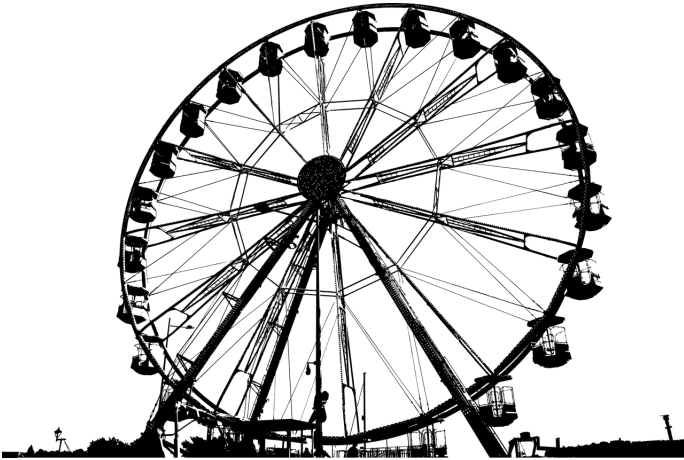


# Fourier Theory: Spectrum analyzer

- You can access the spectrum analyzer by going to Audio Effects → Spectrum.
- To learn what this tool does, we'll discuss some basic concepts of Fourier theory, including frequency and Fourier series



# Fourier Theory: Examples of repeated motion





# Fourier Theory: Frequency

- Frequency = the rate of repeated motion
- Rhythm and pitched sound are examples of repeated motion in music
- Rhythm is movement that has successive strong and weak elements. Sound is vibration that travels through a medium such as air, water, or a physical object.
- We use **beats per minute (BPM)** for low frequency motion like **rhythm** and **cycles per second (Hz)** for higher frequency motion like **pitched sound**
  - Range of rhythm: 1-1000 BPM (0.02-16.7 Hz)
  - Range of pitched sound: 10-20,000 Hz
- White noise is composed of all frequencies in equal amounts.

# Fourier Theory: Terminology

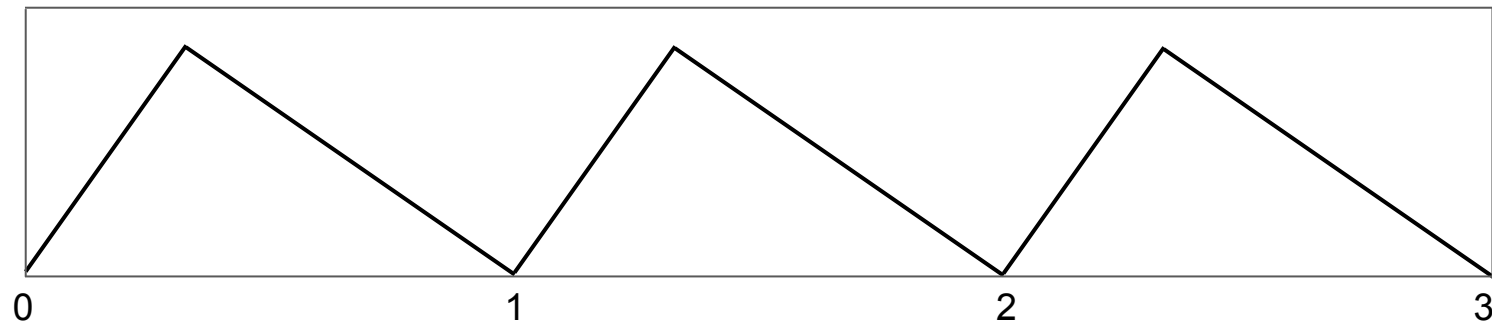
- A **harmonic** is a sound wave whose frequency is some positive integer multiple of a fundamental frequency  $F$  (e.g.  $1F$ ,  $2F$ ,  $3F$ , etc)
- An **overtone** is any sound frequency greater than the fundamental frequency. It may or may not be harmonically-related to the fundamental frequency.
- **Partials** are the fundamental frequency and its overtones (fundamental=1st partial, first overtone=2nd partial, second overtone=3rd partial, and so on).
- **Timbre** describes the quality of a sound. It's what distinguishes, for example, the sound of a clarinet from the sound of a piano. Timbre is quantified by the frequency spectrum (i.e. the fundamental frequency + the overtone structure) and the envelope of the sound (i.e. the loudness of the sound over time).

# Fourier Theory: Fourier series

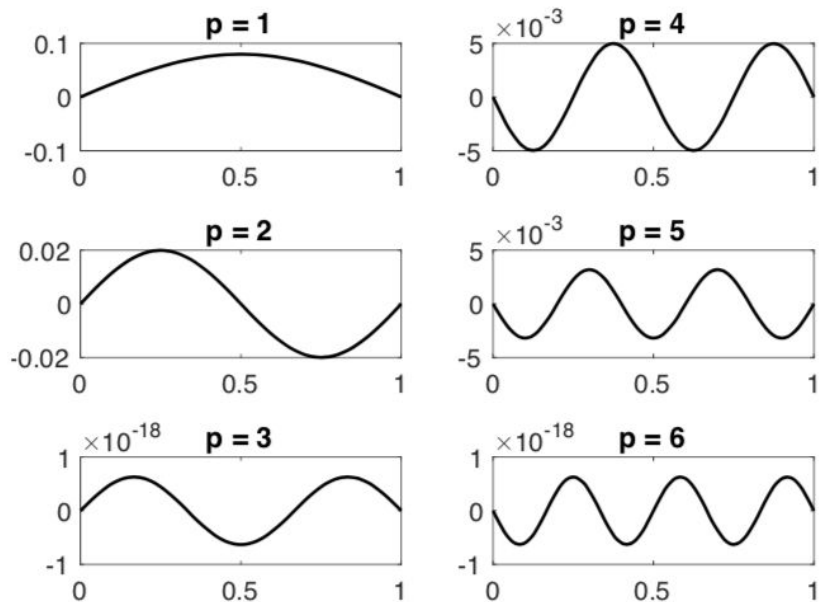
- In the early 1800s, Joseph Fourier and others developed certain mathematical concepts that we use today to analyze sound, such as the idea of a Fourier series.
- A **Fourier series** is a repeating signal (such as a sound wave) that can be expressed as a **weighted** sum of harmonics. (It's like baking a cookie).
  - sound wave = **w1** \* (fundamental) + **w2** \* (2nd harmonic) + **w3** \* (3rd harmonic) + ...
  - cookie = **3 cups** (flour) + **1 cup** (sugar) + **1 cup** (butter) + ...
- The **frequency spectrum** is a plot that shows the distribution of frequencies (and corresponding weights) that make up a sound wave.

# Fourier Theory: Triangle wave example

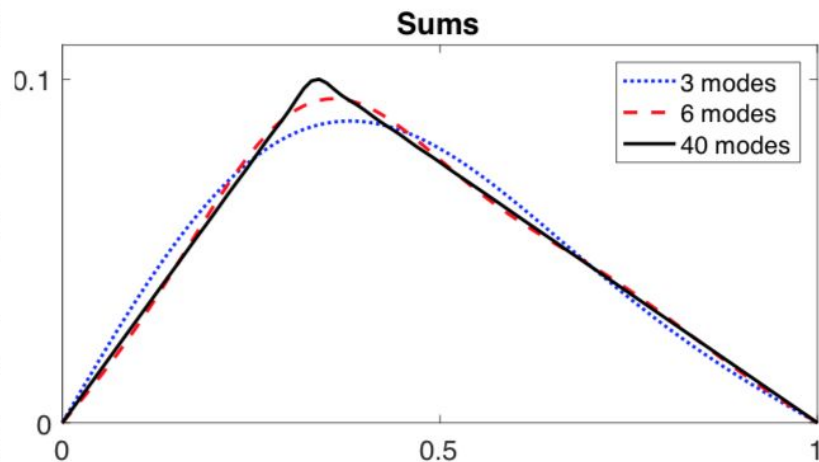
- To see how a Fourier series works, let's consider a simple triangle wave that repeats at some regular interval. We want to find out what frequencies (and corresponding weights) make up this sound wave.



# Fourier Theory: Triangle wave example



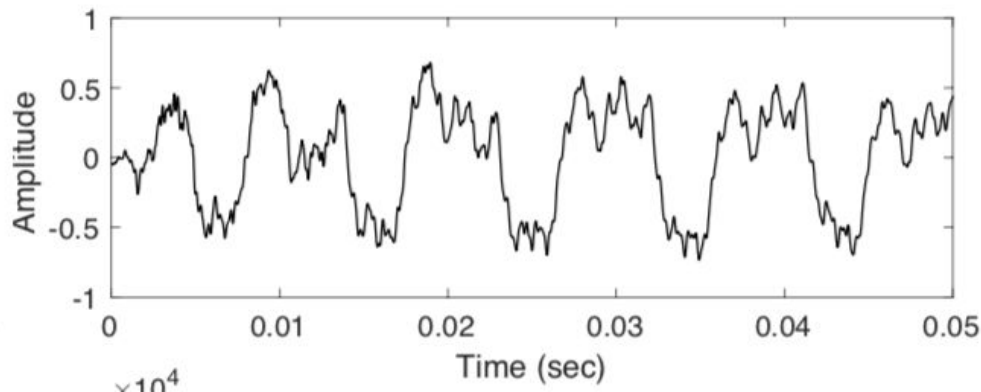
(a) Weighted mode shapes



(b) Sums of mode shapes

# Fourier Theory: Audio example

- Below is an example of a complex audio signal that we may want to analyze using Fourier theory. Notice how the basic shape of the audio signal repeats about every 0.01 seconds.



# **Homework 1 (Ableton Live Basics)**

# Homework 1: Lecture schedule

- **Last Wednesday:**
  - Drum patterns
  - MIDI data
  - Audio samples
- **Today:**
  - Favorites bar
  - Automation
- **Next Wednesday:**
  - Canvas submission guidelines (assignment + discussion)



# Homework 1: Favorites bar

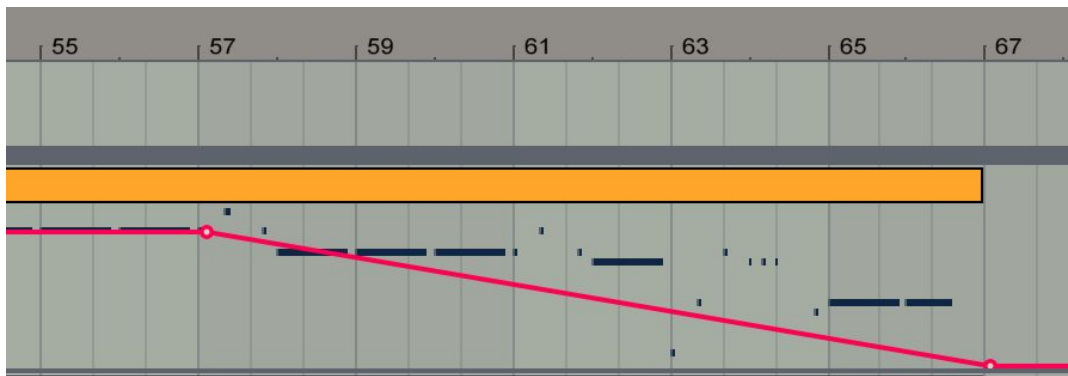
- To add an instrument, audio effect, or other item to your favorites bar, simply right-click on the item in the browser view and select “favorites”.
- This feature only works in Ableton 10.
- For more details about Ableton collections, go to:  
<https://help.ableton.com/hc/en-us/articles/360000268570-Using-Collections>

# Homework 1: Automation

- Automation is a type of technology that allows a machine (e.g. a computer) to perform some kind of task with little or no input from you (the user).
- There are many different types of automation in Ableton: volume automation, effects automation, tempo automation, and so forth.
- Today, we'll discuss a very simple kind of volume automation called a "fade out". We'll go into more depth about automation in the future.
- You only need to use one type of automation to earn full credit for this part of the homework assignment.

# Homework 1: Automation

- To enable automation, click “A” on your keyboard. Then, to enable volume automation, click the volume icon in the arrangement view.
- An example of a “fade out” is shown below. The volume is automatically lowered to zero between measures 57 and 67.



# Questions