

# EN 1-24: Engineering in the Kitchen

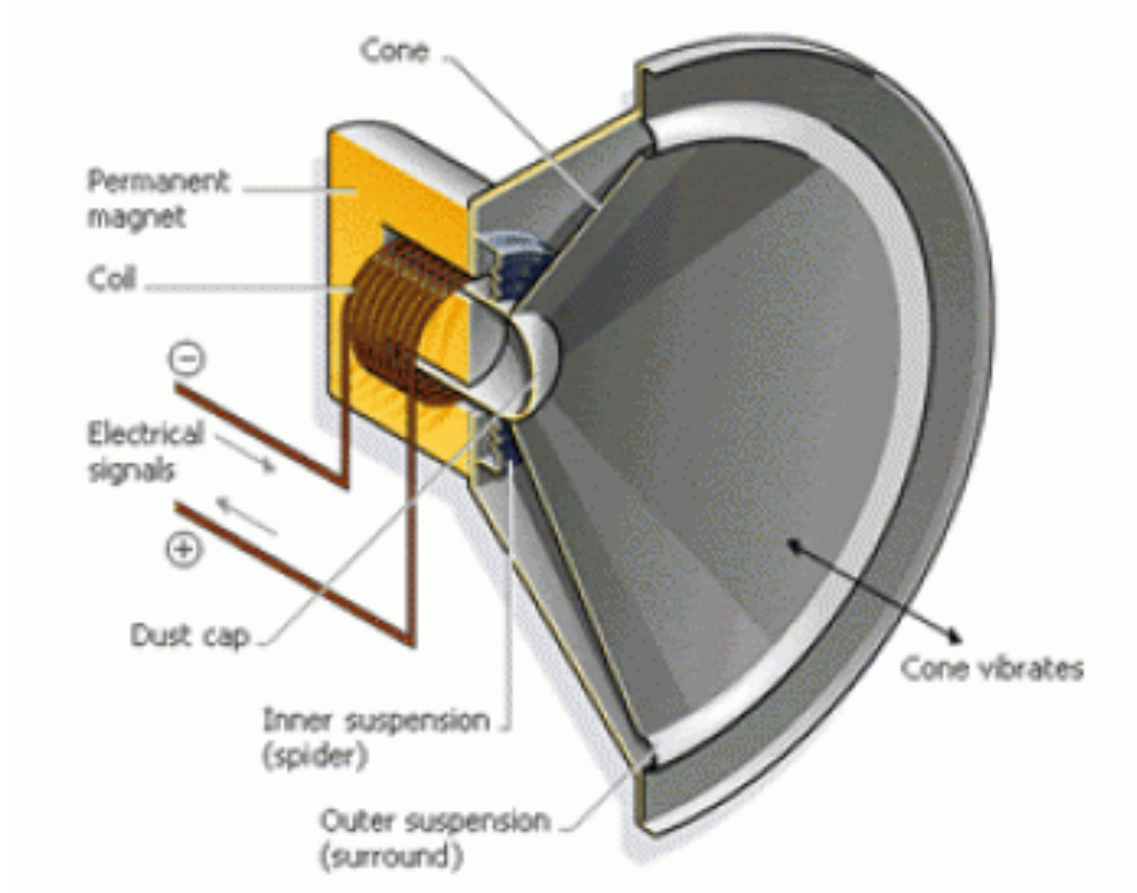
Steven Bell

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# Speakers

Convert changing voltage to sound using an electromagnet



In EE, a **signal** is a quantity  
(such as voltage)  
that varies as a function of time.

# Frequency domain

Voltage vs time isn't the only way to talk about a signal: we might also talk about frequencies.

You can hear "high" and "low" frequencies

An instrument or voice produces harmonics

# Real example: DTMF tones

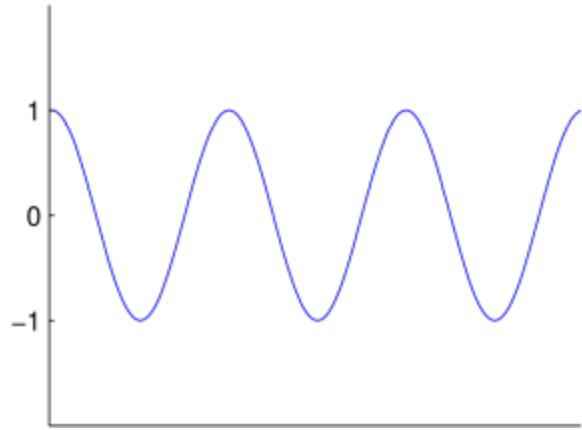
When you get a phone menu, how does the automated system know what button you've pressed?

[onlinetonegenerator.com/dtmf.html](http://onlinetonegenerator.com/dtmf.html)

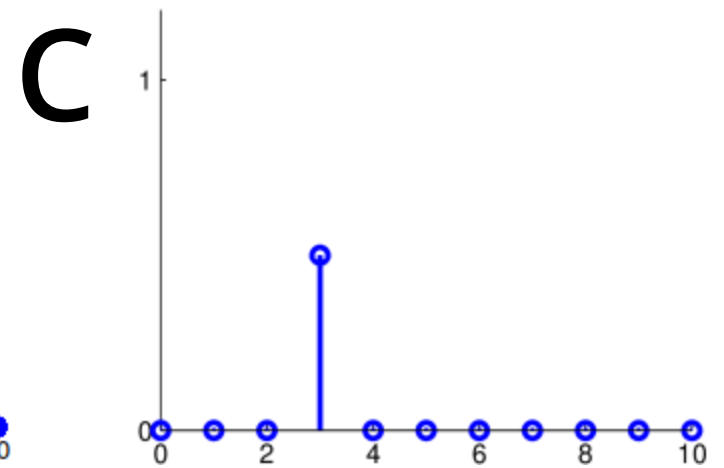
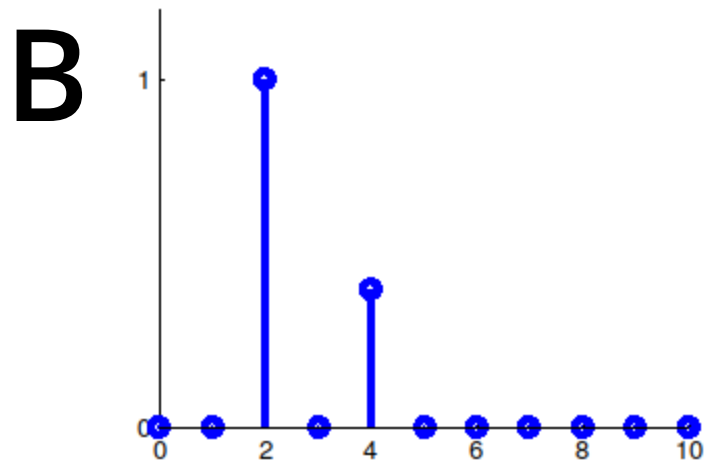
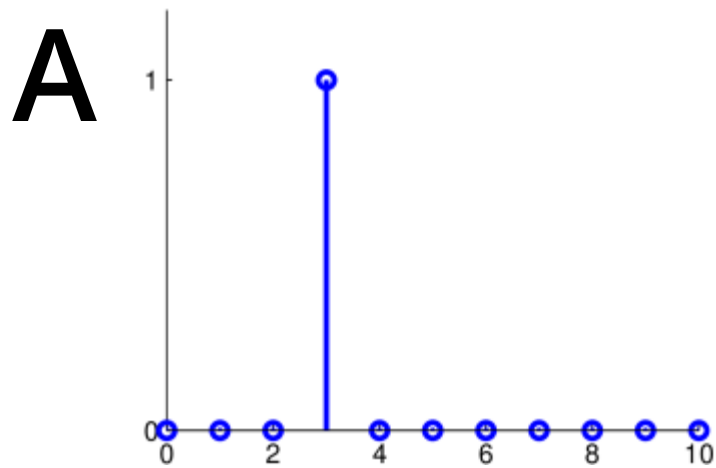
# Fourier series

[falstad.com/fourier/index.html](http://falstad.com/fourier/index.html)

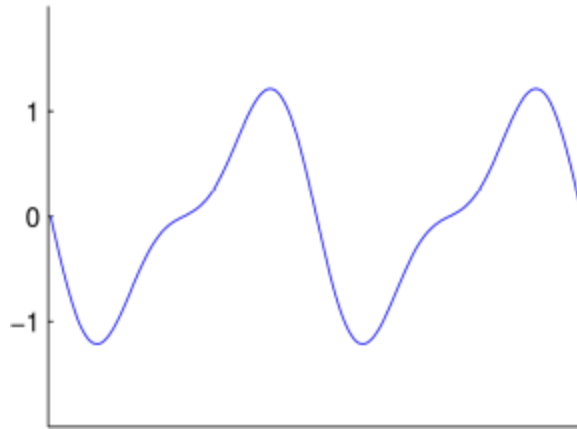
# Matching problem 1



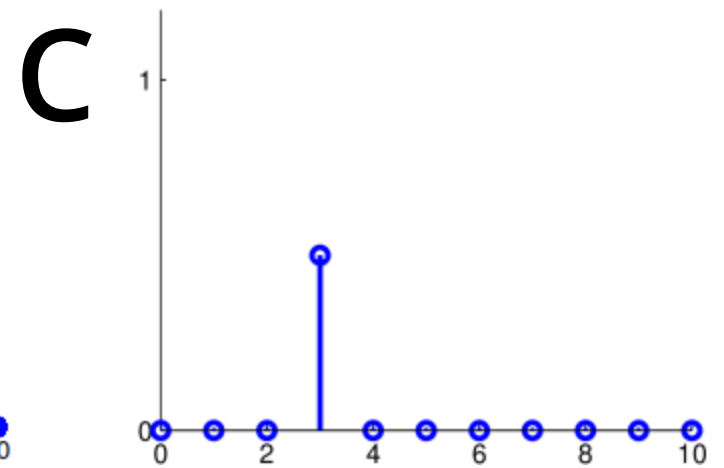
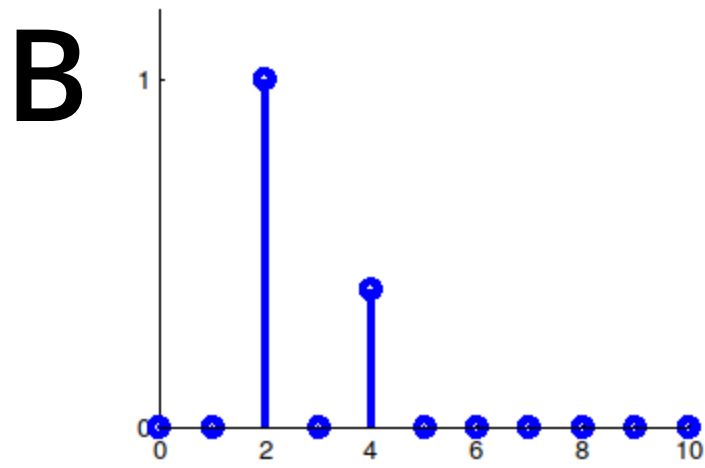
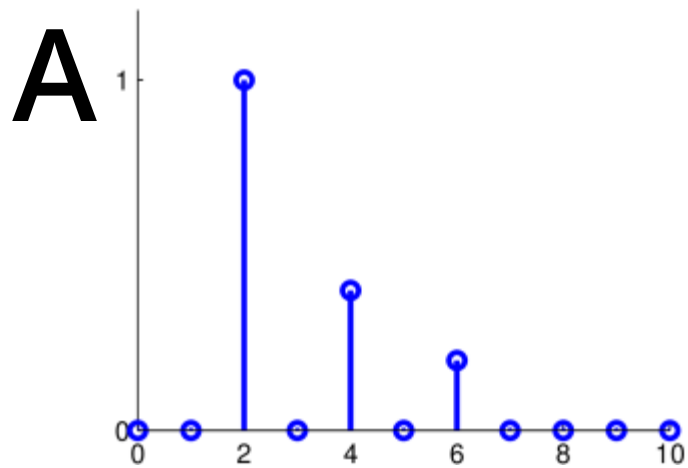
Which is the frequency spectrum for this signal?



# Matching problem 2



Which is the frequency spectrum for this signal?





# Sound with the ESP32

You have to consider sample rate

# Sound with the ESP32

Example posted on the course website soon