Georgia Institute of Technology

Linear Circuits

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An introduction to linear electric components and a study of circuits containing such devices.

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Frequency Spectrum

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Understanding and displaying the frequency content of signals

Module 4:

- Sinusoids and Phasors
- Impedance
- AC Circuit Analysis
- Transfer Functions
- Frequency Spectrum
- Frequency Response
- Filtering

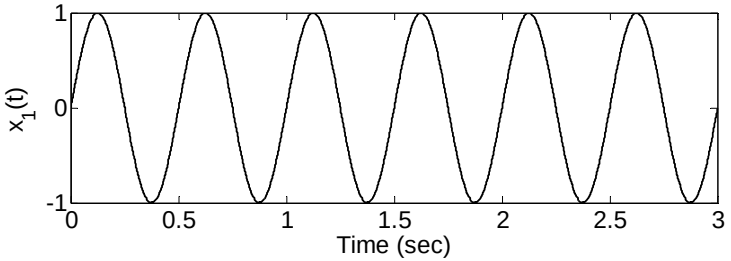
Previous Class

- Introduced the transfer function as a way of computing the circuit response to sinusoids of different frequencies

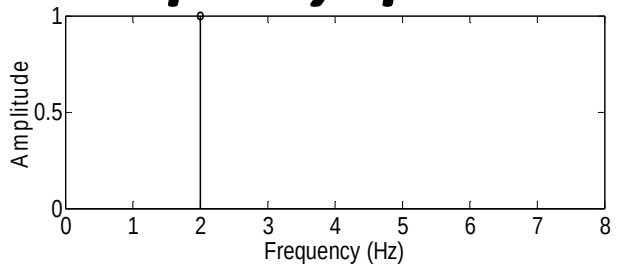
Lesson Objectives

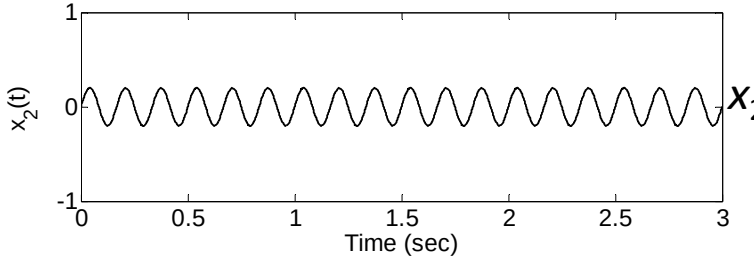
- Introduce the frequency spectrum as a way of showing the frequency content of signals
- Introduce both linear and log scales for displaying frequency content

Summation of Sines

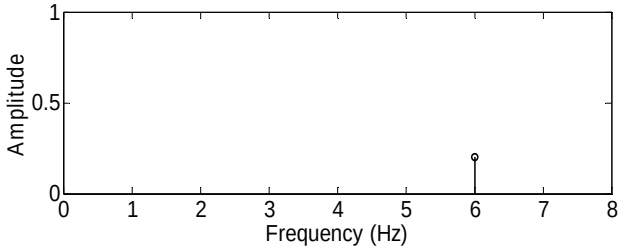


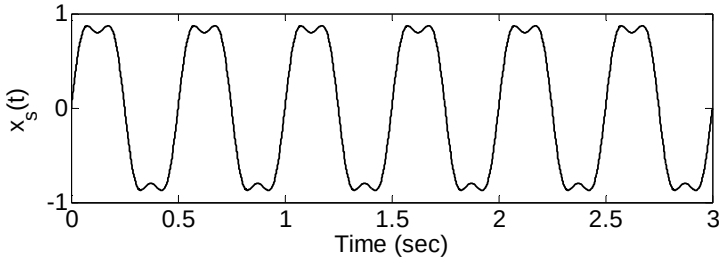
$x_1 = \sin(2\pi 2t)$



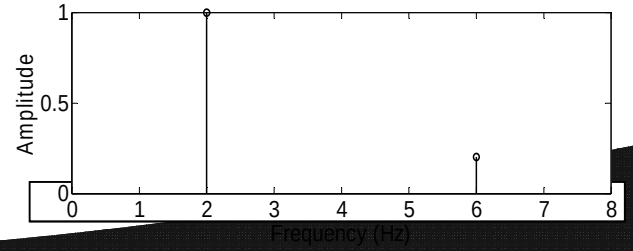


$x_2 = 0.2\sin(2\pi 6t)$



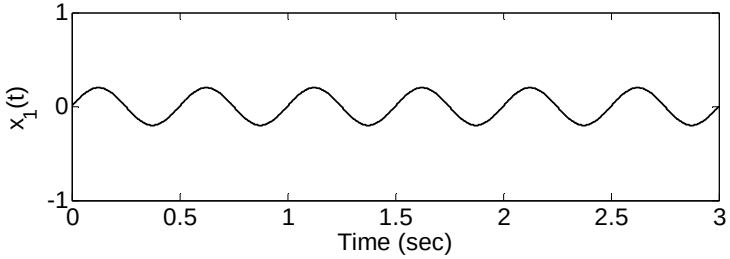


$x_s = x_1 + x_2$

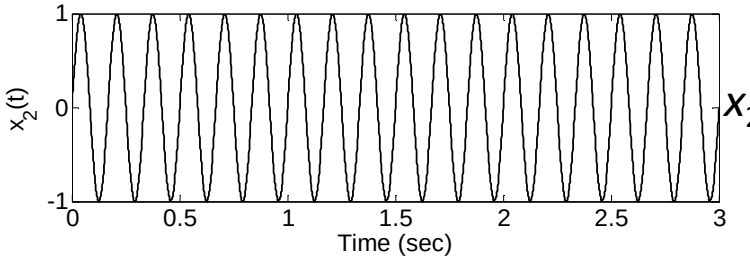


Frequency Spectrum

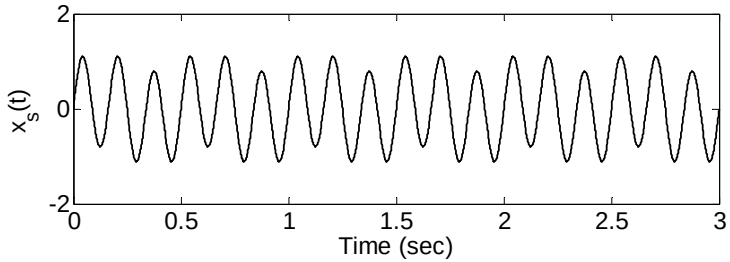
Summation of Sines



$x_1 = 0.2\sin(2\pi 2t)$

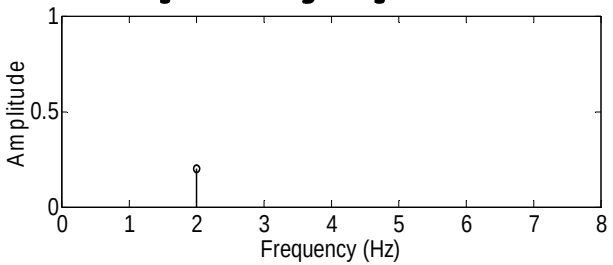


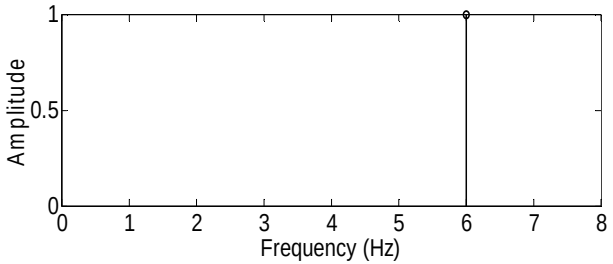
$x_2 = \sin(2\pi 6t)$

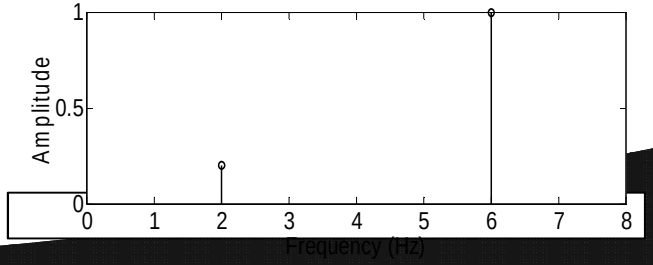


$x_s = x_1 + x_2$

Frequency Spectrum

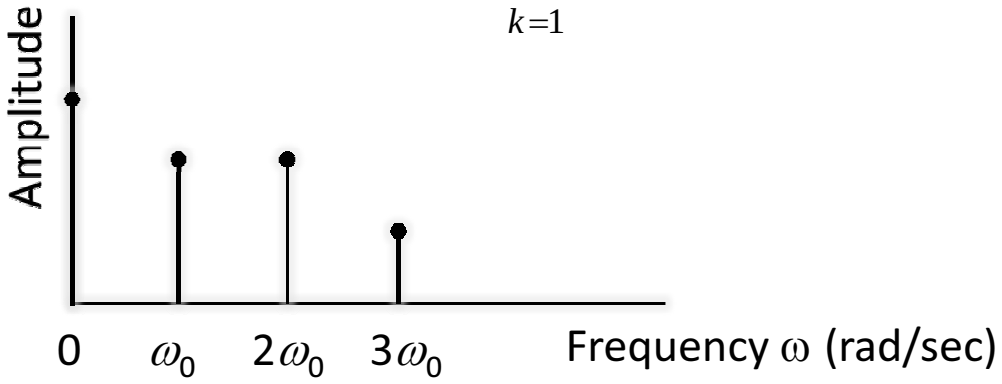




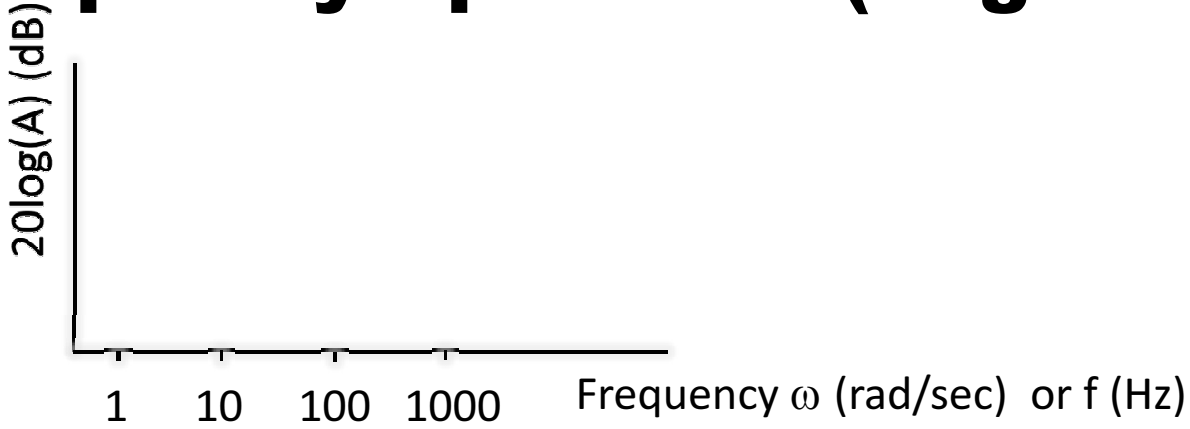


Harmonics

$$x(t) = A_0 + \sum_{k=1}^{N} A_k \cos(k\omega_0 t + \theta_k)$$

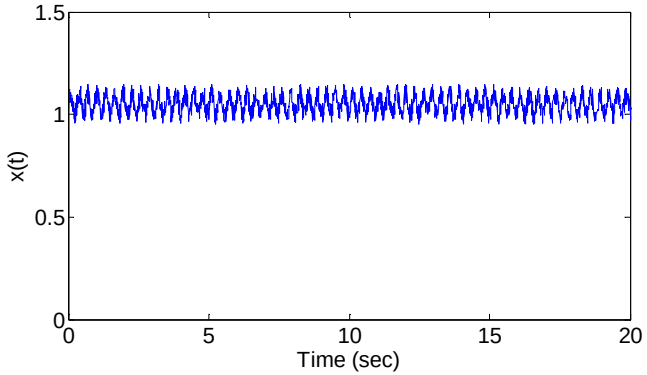


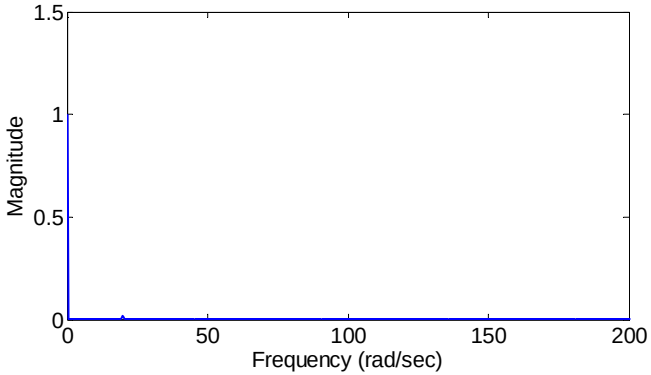
Frequency Spectrum (Log Scale)

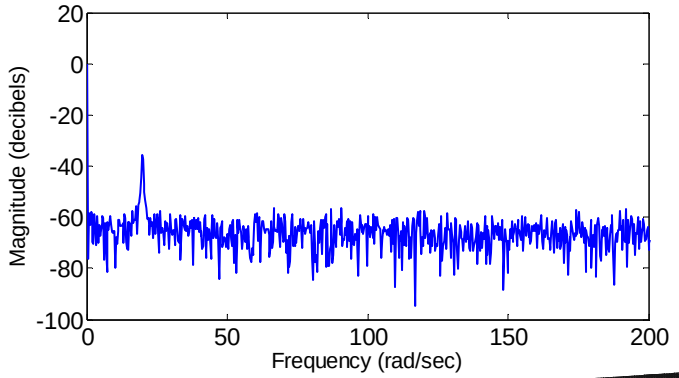


- Some frequency components are better viewed in log scale
- Larger dynamic range while maintaining resolution at the low amplitude range
- Historical usage, going back to time when graphs drawn by hand

Example Spectra







Summary

- A **frequency spectrum** is a plot of the frequency content of signals
- **Harmonics** include a fundamental frequency and multiples of it
- Log scale is often preferred
  - Units are **decibels** or dB

Next Lesson

- Lab demo of a guitar string application