

ECE-2025

Fall-03

LECTURE #1 Sinusoids 18-August-03

INFORMATION

- LABS
 - Room 218 in Bunger-Henry Building
 - MATLAB based computer projects
 - **MATLAB Help: in the evenings**
 - VanLeer, room 261: Wed & Thurs at 6pm
 - Next week: Mon, Tues & Wed at 6pm in VL-261
- RECITATIONS
 - EMPHASIS on Problem Solving
- GRADING ?

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REMINDERS

- Web-CT Login:
 - **gtxxxx** username & PRISM password
- ECE Computer Account
 - All ECE Students have an account
 - www.ece-help.gatech.edu/faq/index.html
- On-Line questions in WebCT
 - Review questions

webct.gatech.edu

- Control Panel
- Visible to Designers
- View Designer Map
- Add Page or Tool
- Manage Files
- Manage Course
- Change Settings
- Content Assistant
- Course Menu
- Homepage
- Syllabus
- Grades
- Bulletin Board
- Calendar
- Hidden
- Quiz Solutions
- Information
- Lectures
- Assignments
- Resources
- "WORD"
- MATLAB GUIs

FALL 2003

Lecture Time: M & F 10:05-10:55 **Room:** W200 Van Leer (Auditorium)
Instructor: [Dr. Jim McClellan](#) **Email:** jim.mcclellan@ece.gatech.edu
Office: BH-325 Bunger-Henry, or 363 GCATT **Phone:** (404) 894-6863 or (404) 894-8325
Office Hours: Mon, Fri 11-12, Wed 12-1, or email to schedule an appointment

Lecture Time: M & F 11:05-11:55 **Room:** W200 Van Leer (Auditorium)
Instructor: [Dr. Aaron Lanterman](#) **Email:** aaron.lanterman@ece.gatech.edu
Office: BH-323, Bunger-Henry, or 334B GCATT **Phone:** (404) 894-8362 or (404) 385-2548
Office Hours: Mon 1-2, Wed 2-3 (VL Lounge), or email to schedule an appointment

For information about recitation instructors and TAs, please refer to the course Information section.

**Recitation meets during the week of 18-Aug in VanLeer, room 361
 Labs will start on 25-Aug in Bunger-Henry 216**

A set of eight navigation icons arranged in two rows. The top row includes: a book icon for 'Syllabus', a pencil holder icon for 'Online PreLabs & Surveys', a chain link icon for '"WORD"', and a pushpin icon for 'Bulletin Board'. The bottom row includes: a document icon for 'Information', a document icon for 'Lectures', a document icon for 'HW and Solutions', and a document icon for 'Lab Assignments'.

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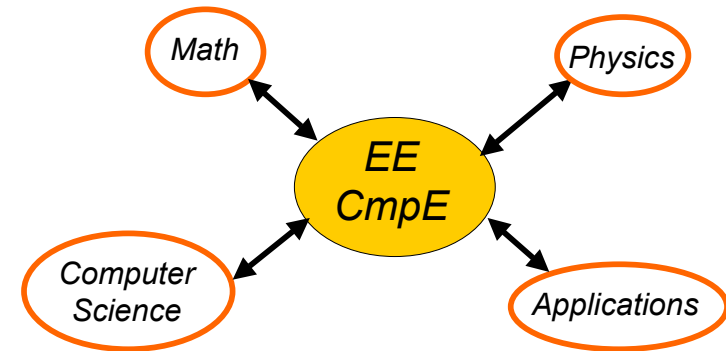
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READING ASSIGNMENTS

- This Lecture:
 - Chapter 2, pp. 9-17
- Appendix A: Complex Numbers
- Appendix B: MATLAB
- Chapter 1: Introduction

CONVERGING FIELDS



COURSE OBJECTIVE

- Students will be able to:
- Understand **mathematical** descriptions of signal processing **algorithms** and express those algorithms as computer **implementations** (MATLAB)
- What are your objectives?


WHY USE DSP ?

- Mathematical **abstractions** lead to generalization and discovery of new processing techniques
- Computer implementations are **flexible**
- Applications provide a **physical** context

LECTURE OBJECTIVES


- Write general formula for a “sinusoidal” waveform, or signal
- From the formula, plot the sinusoid versus time
- What’s a **signal**?
 - It’s a **function** of time, $x(t)$
 - in the mathematical sense

TUNING FORK EXAMPLE

- CD-ROM demo 
- “A” is at 440 Hertz (Hz)
- Waveform is a SINUSOIDAL SIGNAL
- Computer plot looks like a sine wave
- Here is a mathematical formula:

$$A \cos(2\pi(440)t + \varphi)$$

SPEECH EXAMPLE

- More complicated signal (BAT.WAV) 
- Waveform $x(t)$ is NOT a Sinusoid
- Theory will tell us
 - $x(t)$ is approximately a sum of sinusoids
 - FOURIER ANALYSIS
 - Break $x(t)$ into its sinusoidal components
 - Called the FREQUENCY SPECTRUM

DIGITIZE the WAVEFORM

- $x[n]$ is a SAMPLED SINUSOID
 - A list of numbers stored in memory
- Sample at 11,025 samples per second
 - Called the SAMPLING RATE of the A/D
 - Time between samples is
 - $1/11025 = 90.7$ microsec
- Output via D/A hardware (at F_{samp})

STORING DIGITAL SOUND

- $x[n]$ is a SAMPLED SINUSOID
 - A list of numbers stored in memory
- CD rate is 44,100 samples per second
- 16-bit samples
- Stereo uses 2 channels
- Number of bytes for 1 minute is
 - $2 \times (16/8) \times 60 \times 44100 = 10.584$ Mbytes

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SINES and COSINES

- Always use the COSINE FORM

$$A \cos(2\pi(440)t + \varphi)$$

- Sine is a special case:

$$\sin(\omega t) = \cos(\omega t - \frac{\pi}{2})$$

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SINUSOIDAL SIGNAL

$$A \cos(\omega t + \varphi)$$

- **FREQUENCY** ω
 - Radians/sec
 - Hertz (cycles/sec)

$$\omega = (2\pi)f$$

- **PERIOD** (in sec)

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

- **AMPLITUDE** A
 - Magnitude

- **PHASE** φ

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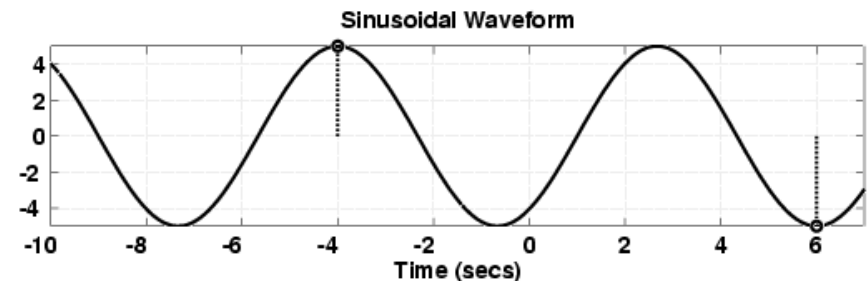
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EXAMPLE of SINUSOID

- Given the Formula

$$5 \cos(0.3\pi t + 1.2\pi)$$

- Make a plot



PLOT COSINE SIGNAL

$$5\cos(0.3\pi t + 1.2\pi)$$

- Formula defines A, ω , and ϕ

$$A = 5$$

$$\omega = 0.3\pi$$

$$\phi = 1.2\pi$$

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PLOTTING COSINE SIGNAL from the FORMULA

$$5\cos(0.3\pi t + 1.2\pi)$$

- Determine **period**:

$$T = 2\pi / \omega = 2\pi / 0.3\pi = 20/3$$

- Determine a **peak** location by solving

$$(\omega t + \phi) = 0 \Rightarrow (0.3\pi t + 1.2\pi) = 0$$

- Zero** crossing is T/4 before or after
- Positive & Negative peaks spaced by T/2

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PLOT the SINUSOID

$$5\cos(0.3\pi t + 1.2\pi)$$

- Use $T=20/3$ and the peak location at $t=-4$

