

ECE-2025

Spring-03

LECTURE #1 Sinusoids 6-Jan-03

INFORMATION

- ◆ LABS
 - ◆ Room 252 in VanLeer Building
 - ◆ MATLAB based computer projects
 - ◆ **MATLAB Help: next week in the evenings**
- ◆ RECITATIONS
 - ◆ EMPHASIS on Problem Solving
- ◆ GRADING ?

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REMINDERS

- ◆ Web-CT Login:
 - ◆ **gtxxxxx** 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

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webct.gatech.edu

The screenshot shows the WebCT interface for the course ECE2025 (Spring). At the top, there is a navigation bar with links for MYWEBCT, RESUME COURSE, COURSE MAP, RESOURCES, LOGOUT, and HELP. Below this is a 'Home' section with a 'View Designer Options' link. The main content area is titled 'Fall Semester 2002: ECE2025 (Spring) All Sections: l...' and includes a 'Home' link. A 'Control Panel' section is visible on the left, listing options like 'Visible to Designer', 'View Designer Ma...', 'Add Page or Tool', 'Manage Files', 'Manage Course', 'Change Settings', and 'Content Assistant'. A 'Course Menu' section lists 'Homepage', 'New Chapters', 'Calendar', 'Information', 'Lectures', 'Assignments', 'Grades', 'Bulletin Board', 'Resources', 'WORD', 'MATLAB GUIs', and 'Quiz Solutions'. The main content area displays 'SPRING 2003' information: 'Lecture Time: M & F 11:05-11:55', 'Room: W200 Van Leer (Auditorium)', 'Instructor: Dr. Jim McClellan', 'Email: jim.mcclellan@ece.gatech.edu', 'Office: E475-C Van Leer, or 363 GCATT', 'Phone: (404) 894-6863 or (404) 894-8325', and 'Office Hours: Mon, Fri 12-1, Wed 10:30-11:30, or email to schedule an appointment'. A yellow banner states 'Labs start on Monday, 13-Jan, in VanLeer room 252'. Below the banner are icons and links for 'New Chapters for SP First and DSP First', 'WORD', 'Bulletin Board', 'Information', 'Lectures', 'HW and Solutions', 'Lab Assignments', and 'Resources'.

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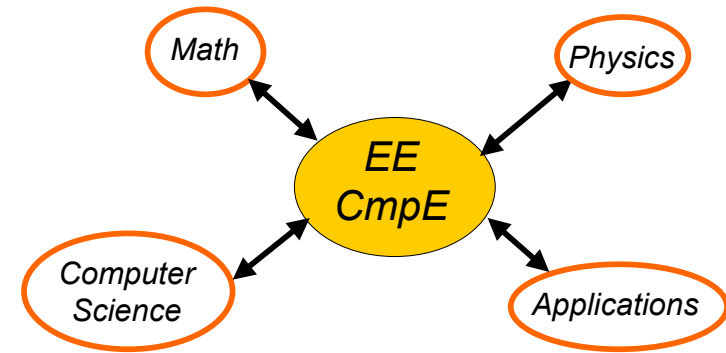
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READING ASSIGNMENTS

- ◆ 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.MAT)
- ◆ 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

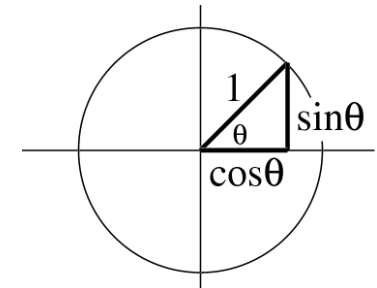
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TRIG FUNCTIONS

- ◆ Circular Functions



- ◆ Common Values

- ◆ $\sin(k\pi) = 0$
- ◆ $\cos(0) = 1$
- ◆ $\cos(2k\pi) = 1$ and $\cos((2k+1)\pi) = -1$
- ◆ $\cos((k+0.5)\pi) = 0$

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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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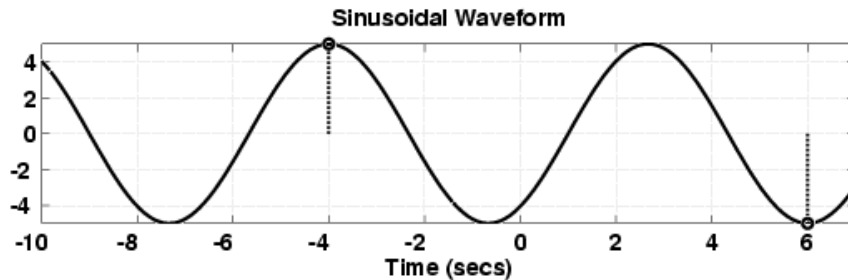
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EXAMPLE of SINUSOID

- ◆ 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

$$(\omega t + \phi) = 0$$

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

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