

# ECE-2025

# Fall-01

## LECTURE #1 Sinusoids 20-Aug-01

## INFORMATION

### LABS

- Room **252** in VanLeer Building
- MATLAB based computer projects
- MATLAB Help: next week in the evenings**

### RECITATIONS

- Room **361** in VanLeer Building
- EMPHASIS on Problem Solving

### GRADING ?

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## COMPUTER ACTIVITIES

### Web-CT

- webct.gatech.edu**, then select course
- Username = **gtxxxxx**
- Password = Last 4 digits of Student Number(SSN)

### ECE Computer Account

- All ECE Students have an account
  - First-Time Password = Student Number
- Otherwise, **www.ece-help.gatech.edu**

### On-Line HW #0 in WebCT

- Due NEXT Monday before midnight**
- It's a review

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WebCT MYWEBCT | RESUME COURSE | COURSE MAP | HELP

ECE2025 All Sections: Introduction to Signal Processing

### ECE-2025: Introduction to Signal Processing

SPRING 2001

**Lecture Time:** M & F 11:05-11:55      **Room:** W200 Van Leer (Auditorium)  
**Instructor:** [Dr. Ron Schafer](mailto:ron.schafer@ece.gatech.edu)      **Email:** [ron.schafer@ece.gatech.edu](mailto:ron.schafer@ece.gatech.edu)  
**Office:** E475-D Van Leer, or 321 GCATT      **Phone:** (404) 894-6863 or (404) 894-2917  
**Office Hours:** Mon 1-3, Th 4-6, or email to schedule an appointment

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

[Surveys, Online Quizzes and HWs](#)      [New Chapters: Continuous-Time Signals & Systems](#)      ["WORD"](#)      [Bulletin Board](#)

[Information](#)      [Resources](#)      [Quiz Solutions](#)

## READING ASSIGNMENTS

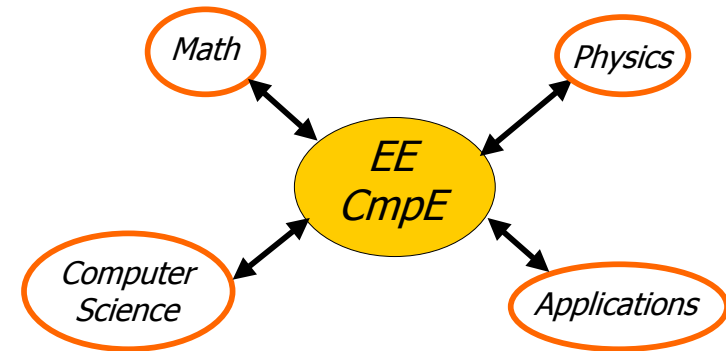
- This Lecture:
  - Chapter 2, pp. 9-17
- Appendix A: Complex Numbers
- Appendix B: MATLAB
- Chapter 1: Introduction

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## CONVERGING FIELDS



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## 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?

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## WHY USE DSP ?

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

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## LECTURE OBJECTIVES

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- 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

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- 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

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- More complicated signal (BAT.MAT)
- Waveform  $x(t)$  is NOT a Sinusoid
- BUT, the 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

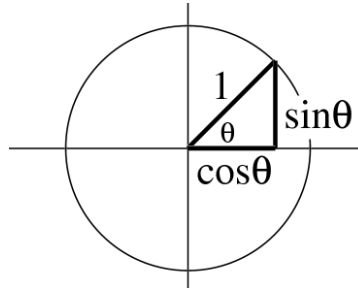
## DIGITIZE the WAVEFORM

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- $x[n]$  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  $F_{\text{samp}}$ )

# TRIG FUNCTIONS

## ■ Circular Functions



## ■ Common Values

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

# SINES and COSINES

- **Always** use the COSINE FORM

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

- Sine is a special case:

$$\sin(\omega t) = \cos(\omega t - \pi / 2)$$

# SINUSOIDAL SIGNAL

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

## ■ FREQUENCY $\omega$

- Radians/sec
- Hertz (cycles/sec)

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

## ■ PERIOD (in sec)

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

## ■ AMPLITUDE $A$

- Magnitude

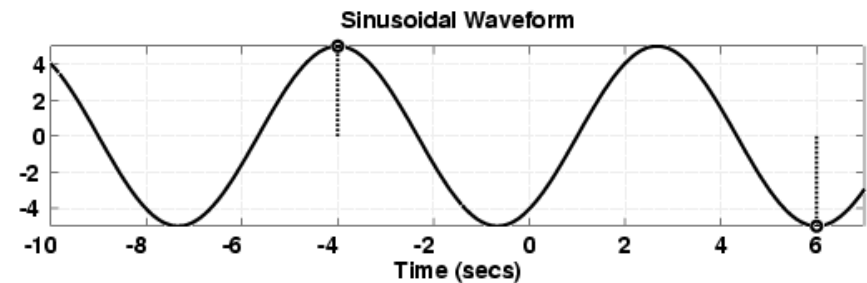
## ■ PHASE $\varphi$

# EXAMPLE of SINUSOID

- Given the Formula

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

- Make a plot



## EXTRACT cos PARAMETERS

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

- Formula defines  $A$ ,  $\omega$ , and  $\phi$

$$A = 5$$

$$\omega = 0.3\pi$$

$$\phi = 1.2\pi$$

## PLOTTING COSINE SIGNAL from the FORMULA

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

- 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 & Neg. peaks spaced by  $T/2$

## PLOT the SINUSOID

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

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

