

# ECE-2025

# Fall-00

## LECTURE #1 Sinusoids 21-Aug-00

# INFORMATION

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

8/20/00

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# REMINDERS

- Web-CT Password:
  - SSN or Student Number
- ECE Computer Account
  - All ECE Students have an account
  - Otherwise, check in room 309 of CoC Building
- On-Line HW in WebCT
  - **Due NEXT Monday**
  - It's a review

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**ECE-2025: Introduction to Signal Processing**

Fall-1999

Lecture Time: M & F 12:05-12:55      Room: W200 Van Leer (Auditorium)  
Instructor: Dr. Ron Schafer      Email: ron.schafer@ece.gatech.edu

Use login "anon" with password "anon" for anonymous postings to bulletin board.

quiz	Quiz Solutions	Course & Lab Info	Homework Assignments & Solutions
Online HW, Quizzes and Surveys	LAB Assignments	bulletins Bulletin Board	tools Course Tools and Grades
Movies Real-Media Tutorials	Lecture Notes	WORD from Previous Quarters	Extra M-Files for Labs
mail Private Mail			

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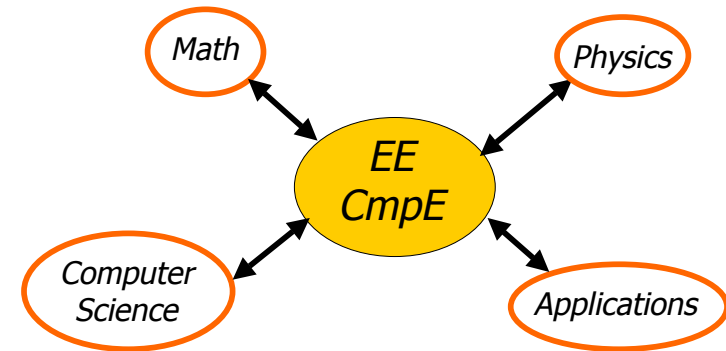
## READING ASSIGNMENTS

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

## CONVERGING FIELDS

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## COURSE OBJECTIVE

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- 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 ?

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

## 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  $\mathbf{x(t)}$  is NOT a Sinusoid
- Theory will tell us
  - $\mathbf{x(t)}$  is approximately a sum of sinusoids
  - FOURIER ANALYSIS
    - Break  $\mathbf{x(t)}$  into its sinusoidal components
  - Called the FREQUENCY SPECTRUM

## DIGITIZE the WAVEFORM

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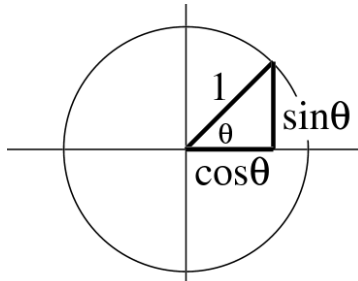
- $\mathbf{x[n]}$  is a SAMPLED SINUSOID
  - A list of numbers stored in memory
- Sample at 11,025 samples per second
  - Called the SAMPLING RATE of the A/D
  - Time between samples is
    - $1/11025 = 90.7$  microsec
- Output via D/A hardware (at  $F_{\text{samp}}$ )

# 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

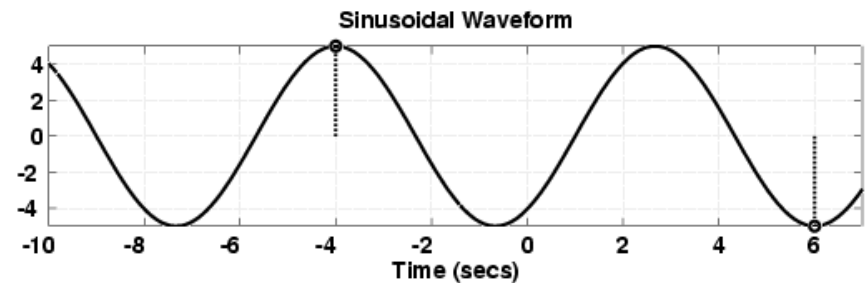
- **PHASE**  $\varphi$

# EXAMPLE of SINUSOID

- Given the Formula

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

- Make a plot



## PLOT COSINE SIGNAL

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

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

$$A = 5$$

$$\omega = 0.3\pi$$

$$\phi = 1.2\pi$$

## PLOTTING COSINE SIGNAL from the FORMULA

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

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