

# ECE-2025

# Fall-99

## LECTURE #1

### Sinusoids

### 23-Aug-99

# INFORMATION

## LABS

- Room 309 in CoC Building
- MATLAB based computer projects
- MATLAB Help: next week in the evenings**

## RECITATIONS

- EMPHASIS on Problem Solving

## GRADING ?

# REMINDERS

## Web-CT Password:

- SSN(4:8), 4th thru 8th digits of SSN

## Activate your ECE Computer Account

- in room 309 of CoC Building
- Thurs/Fri (or at least before Lab)

## On-Line HW in WebCT

- Due THIS Friday**
- It's a review

## ECE-2025: Introduction to Signal Processing

Fall-1999

Lecture Time: M & F 12:05-12:55

Instructor: [Dr. Ron Schafer](#)

Room: W200 Van Leer (Auditorium)

Email: [ron\\_schafer@ece.gatech.edu](mailto:ron_schafer@ece.gatech.edu)

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



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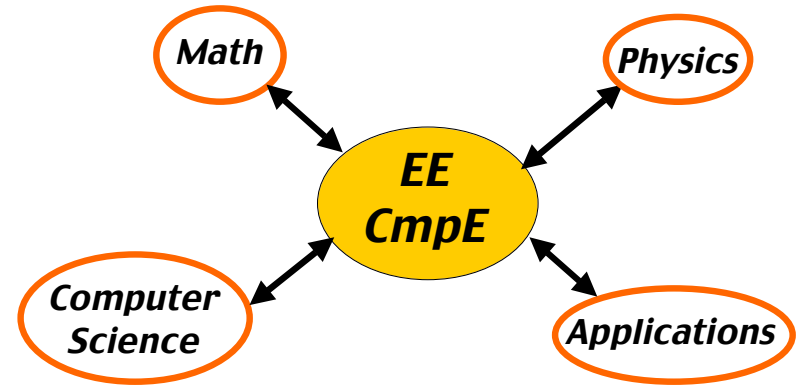


[Private Mail](#)

## 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

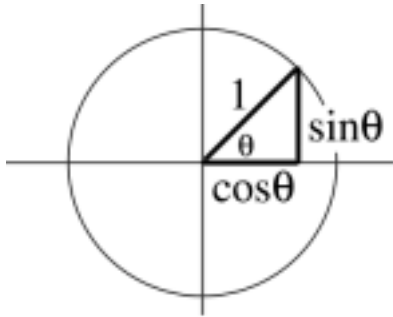
- $x[n]$  is a **SAMPLED SINUSOID**
  - A list of numbers stored in memory
- Sample at 11,025 samples per second
  - Called the **SAMPLING RATE** of the A/D
  - Time between samples is
    - $1/11025 = 90.7$  microsec
- Output via D/A hardware (at  $F_{\text{samp}}$ )

# 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)

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

- AMPLITUDE  $A$ 
  - Magnitude

- PERIOD (in sec)

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

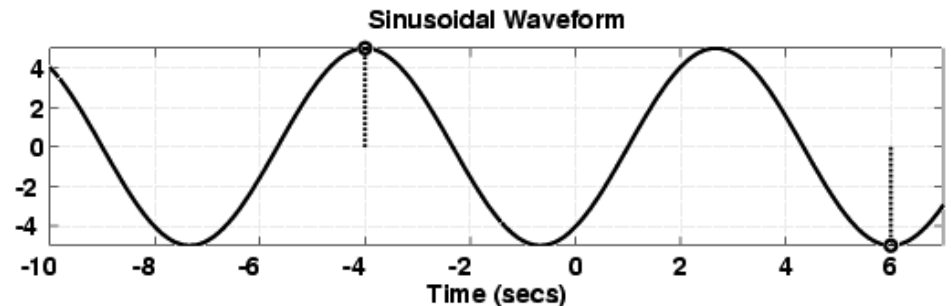
- PHASE  $\varphi$

# 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  $T/2$