ECE-2025 Fall-99

LECTURE #1

Sinusoids

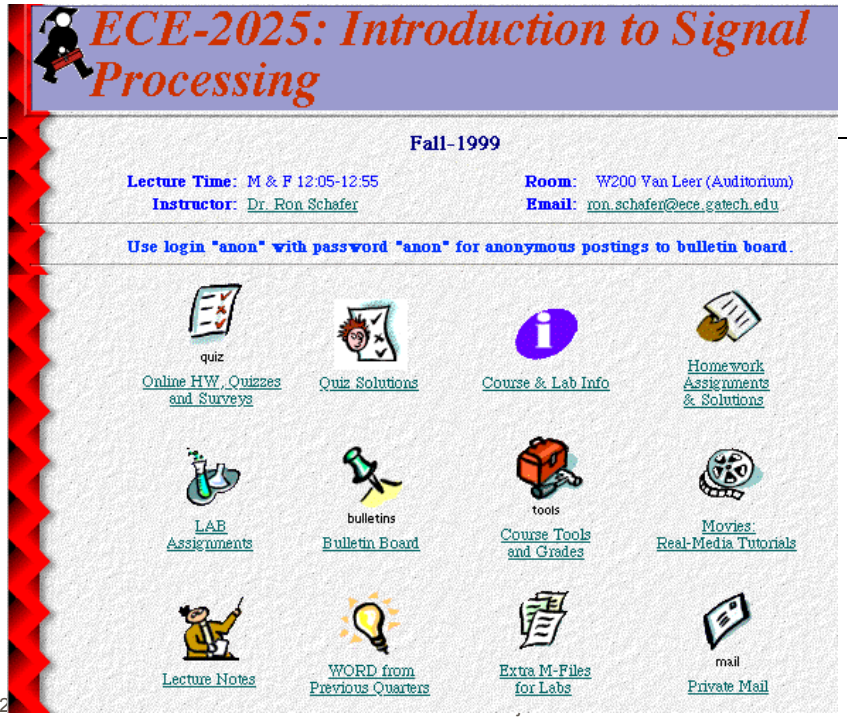
23-Aug-99

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

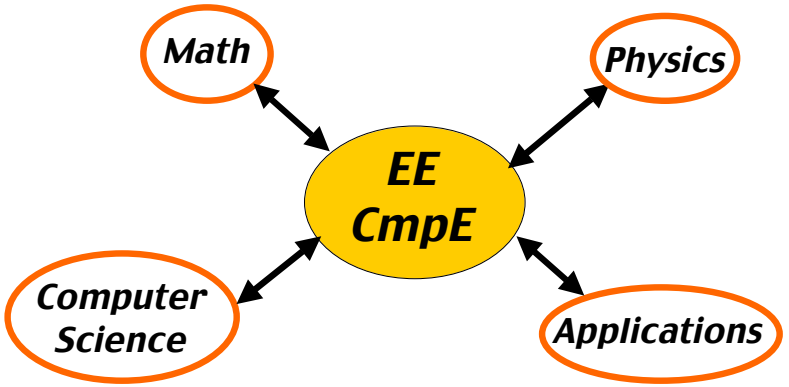
- Web-CT Password:
  - SSN(4:8), 4th thru 8th digits of SSN
- Activate your ECE Computer Account
  - in room 309 of CoC Building
  - Thurs/Fri (or at least before Lab)
- On-Line HW in WebCT
  - Due THIS Friday
  - It's a review



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

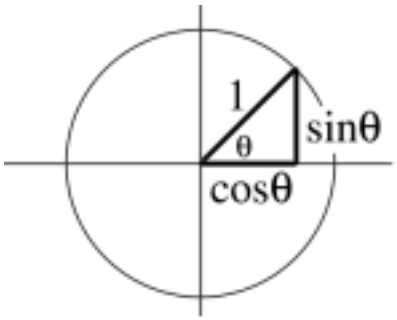
- More complicated signal (BAT.MAT)
- Waveform $x(t)$ is NOT a Sinusoid
- Theory will tell us
  - $x(t)$ is approximately a sum of sinusoids
  - FOURIER ANALYSIS
    - Break $x(t)$ into its sinusoidal components
  - Called the FREQUENCY SPECTRUM

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})

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

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

- AMPLITUDE A
  - Magnitude
- PHASE φ
- PERIOD (in sec)

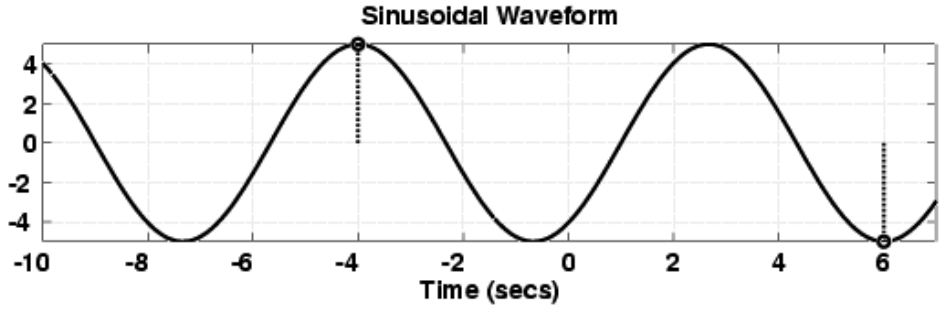
$$T=\frac{1}{f}=\frac{2\pi}{\omega}$$

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

$$A = 5$$
$$\omega = 0.3\pi$$
$$\varphi = 1.2\pi$$

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

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

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