GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL of ELECTRICAL and COMPUTER ENGINEERING

ECE 2025 Fall 2000
Lab #12: AM Communication System

Date: 27 Nov.–1 Dec. 2000

This is *the official* Lab #12 description. **If you have a PC-compatible microphone (and headphones), please bring them to lab for the warm-up.**

Next week (4–7 Dec) lab will be held. You will have to fill out surveys and also demonstrate your working AM system.

The lab report for this lab will be **INFORMAL**. Include explanations as well as spectrogram plots to illustrate the spectral content of the AM signals in Part 3.

The report will **due during the week of 4 Dec. at the start of your lab.**

---

1 Introduction & Objective

The goal of this laboratory project is to illustrate the inner workings of a communication system based on AM (Amplitude Modulation). Ideally your lab report should demonstrate that you can produce a functional AM system that operates on a voice signal.

1.1 Think Independently

One objective of your education is to **"learn how to learn"** and how to extend your skills on your own. Thus the second goal in this lab is for you to demonstrate that you can "Think independently." As a result, the lab instructions are minimal, but should be well within your capability as an experienced MATLAB user.

Your written lab report should document that you can produce an interesting demonstration of AM. There are many ways to do this, so formulate your own plan of action.

2 Warmup

In this warm-up you must do three things:

(a) Demonstrate to your TA that you can record a few seconds of your voice at $f_s = 44,100$ Hz. Use the Windows-98 Accessory called *Sound Recorder* and save the signal as a WAV file. When you need the signal in MATLAB, use the function `wavread()`.
Instructor Verification (separate page)

(b) Design an FIR lowpass filter based on the Hamming window idea of an earlier lab (on octave filtering). Exhibit the filter's frequency response. For the warmp-up, use the following parameters: cutoff frequency of 2 kHz and sampling frequency of 44.1 kHz. What is the length of the FIR filter ?
Instructor Verification (separate page)

(c) Filter your voice signal through the lowpass filter. Play out the result to verify that it sounds acceptable. Convince your TA that the output has no frequency components above 2 kHz (by using an appropriate plot).
Instructor Verification (separate page)

3 AM Communication System

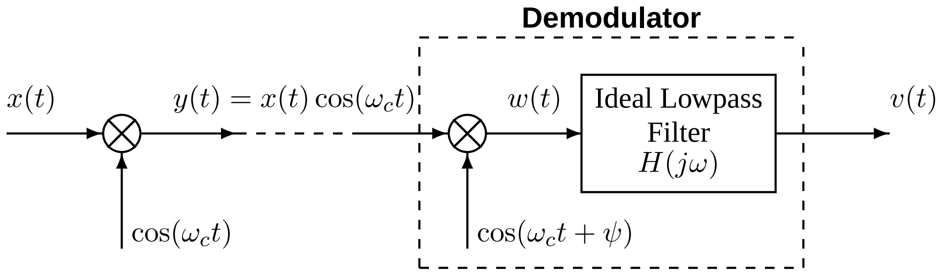

Figure 1: Block diagram of sinusoidal modulation followed by demodulation with variable phase.

In this part of the lab project, you must do an implementation of a single channel AM communication system (Fig. 1). Here are the steps:

1. Make an input signal by recording your voice for a few seconds. Use a sampling rate of 44.1 kHz. The best test signal would have lots of vowels.
2. Filter the voice signal with a lowpass filter whose cutoff frequency is 4 kHz.
3. Display the spectrogram of your filtered voice and *estimate* the bandwidth of the speech signal.
4. Make an AM signal by multiplying your voice by a cosine. Use a "carrier frequency" that is between 10 kHz and 15kHz.[1]
5. Demodulate the AM signal. Use a demodulator that has phase dependence. Try to get the best output, where "best" means the strongest output signal.
6. Demonstrate how the demodulator output depends on the phase. Show that for one choice of the phase that you get zero output.
7. Demonstrate your working system to your lab TA.

Make spectrograms at the appropriate points to show what's happening to the signal in the frequency domain, e.g., show the spectrogram at each point in the demodulator.

3.1 Explanations

Explain using Fourier transforms, mathematics and sketches how your AM system works One aspect of this is to explain why "phase matters" in the receiver's mixer, but it is also important to draw sketches of the Fourier transform to show where the signal's spectrum lies at any point in the system. Make a spectrogram at certain key places in the system to explain what is going on. You don't need every one, but you should use the Fourier knowledge that you gained in the previous part to decide which ones are useful.

3.2 Note on Simulation Frequency

A true AM system is a continuous-time (or analog) system. However, in this lab we are using MATLAB to simulate the analog system. The simulation rate is 44.1kHz. Therefore, every signal in the simulation must be sampled at $f_s = 44.1$ kHz, and every digital filter must be designed for 44.1 kHz.

[1] To make your choice of frequency unique, pick the carrier frequency as follows: take the last 4 digits of your SSN, divide by 2 and then add 10,000. Finally, round to the nearest multiple of 100.

Lab #12
ECE-2025 Fall-2000
Instructor Verification

Name: ______________________________ Date of Lab: ________

Part 2(a): Record your voice and show a spectrogram in MATLAB of the resulting signal.

Verified:_______________ Date/Time:________

Part 2(b): Design an digital lowpass filter with a specified passband. This digital filter will be used to filter analog signals sampled at 44.1kHz, so make a plot of its frequency response (magnitude) versus ω in rad/sec. Determine the stopband region from the plot.

Verified:_______________ Date/Time:________

Part 2(c): Filter your voice signal. Convince your TA that it has no components above 2 kHz (approximately).

Verified:_______________ Date/Time:________

Evaluation: Demonstrate your working system to you TA. Explain how it works. Listen to the output signal for the maximum output.

Verified:_______________ Date/Time:________

Verify the output when the phase of the demodulator is changed to produce zero.

Verified:_______________ Date/Time:________