Name:______________________

Date:_________________

EO 3513

COMPUTER-AIDED LABORATORY 5 (lab5.m)
Amplitude Modulation

I. Discussion

This series of laboratory experiments uses MATLAB^{tm} files which are part of the Communications Toolbox for MATLAB being developed in the NPS Advanced Communications Laboratory. The files necessary to run these laboratories are contained in a directory titled **eo3513** and will run under MATLAB 4.2 for Windows. The **eo3513** directory must be included in the MATLABPATH command in the matlabrc.m file (see MATLAB reference manual) on the platform you are using.

These laboratories are written as what are known as "MATLAB script m-files". You really don't need to know any MATLAB to run them. They are interactive. During their execution, you will be asked to enter numerical values for things like frequency, amplitude, sampling rate, pulse width, etc. and to set up time and/or frequency scales.

The m-file for this laboratory is **lab5.m**. To execute, simply type **lab5** at the MATLAB prompt. You can find the file in the **eo3513** directory. It may be useful to print it out before you begin.

Part 1: AM modulation with a sinusoid test tone

In this part, Ordinary AM and DSBSC AM signals are generated using the test sinusoid message signal

$m = \cos(2\pi f_m t)$.

You will be asked to enter f_m , the frequency of the sinusoid. You may choose any value between 50 Hz and 400 Hz. You will then be asked to enter u, the modulation index and A_c, the carrier frequency amplitude.

The signal

kam = u*m is used to generate the ordinary AM signal

s1=A_c(1+kam)cos(2*pi*fc*t).

The carrier frequency fc is set to 2000 Hz in the program.

The sinusoid message signal m and 1+kam are plotted as Plot 1 of Fig. 1. The ordinary AM signal s1 is plotted as Plot 2 of Fig. 1.

Plot 3 of Fig. 2 is a plot of the spectrum of the message m. Plot 4 of Fig. 2 is a plot of the spectrum of the AM signal s1.

The DSBSC signal

$s2=A_c$*m*cos(2*pi*fc*t)

is generated and plotted as Plot 5 of Fig. 3. The spectrum of s2 is Plot 6 of Fig. 3.

Part 2: The AM modulation and demodulation process with a multi-tone message signal

In this part you will use the message signal

m= cos(2*pi*fm*t) + cos(2*pi*(fm/2)t) + sin(2*pi*(fm/4)*t)

to create ordinary AM signal s1 with a modulation index u, DSBSC signal s2 and SSBSC signal s3. The value of the AM gain constant ka for the ordinary AM signal is computed as

ka = u/max(abs(m))

and printed out for you. Thus the signal kam = ka*m will have a maximum absolute value of u as required.

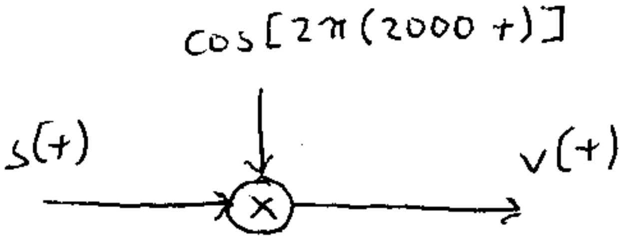
Plot 7 of Fig. 4 is a plot of m and 1+kam. Plot 8 of Fig. 4 is the ordinary AM signal s1.

Plot 9 of Fig. 5 is the spectrum of multitone message m. Plot 10 is the spectrum of the AM signal s1.

Next, we recover the message signal m from the ordinary AM signal s1 using an envelope detector. Plot 11 of Fig. 6 shows the absolute value of the AM signal s1 and the envelope detector output connecting the peaks. Plot 12 of Fig. 6 shows the envelope signal with the bias removed and the gain restored (dividing by $ka*A_c$). The original message signal m is shown for comparison.

Plot 13 of Fig. 7 shows the DSBSC signal s2 using the multitone message signal m. Plot 14 of Fig.7 shows the spectrum of s2.

Plot 15 of Fig. 8 shows the SSBSC signal s3 obtained by passing s2 thru a SSB filter. Plot 16 of Fig. 8 shows the spectrum of s3.



Coherent Detector

Referring to the diagram above of a coherent detector, Plot 17 of Fig. 9 shows spectrum of x, the output of the multiplier when the input is s2, the DSBSC signal. Plot 18 of Fig. 9 shows the spectrum of x when the input is s3, the SSBSC signal.

Plot 19 of Fig. 10 shows v2, the output of the coherent detector, in the time domain, for the DSBSC signal. Plot 20 of Fig. 10 shows v3, the output of the coherent detector for the SSBSC signal. You will be asked to enter f_{co}, the cutoff frequency for the LPF.

II. Procedure

1. Typical Values

a. Run the program **lab5** using the following values for the parameters;

Freq. of message:	f_3 = 200 Hz
AM modulation index:	u = .8
Carrier amplitude:	A_c = 4
LPF cutoff:	f_{co} = 500 Hz.

b. Plot the Figure windows using the **print** command.

2. Experimental Values

a. Run the program several more times trying different combinations of the parameters.

b. Collect only one more sets of plots. This set should use a value for the modulation index u that is greater than one to create a situation of overmodulation for the ordinary AM. Observe what happens to the output of the envelope detector for this case.

III. Report

1. Compute and sketch the Fourier transforms for the message signal m and for the three signals s1, s2 and s3 for both the single tone and multi-tone message signals. Compute and sketch the Fourier transform for the multiplier outputs x2 and x3 for DSBSC input s2 and the SSBSC input s3. Compare these to your experimental results and comment.

2. Is this SSB transmission using the upper or lower sideband?

3. Discuss your choice for the cutoff frequency you used in the low pass filter for signal recovery.