USAF ACADEMY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
LESSON 6 LAB - AM Simulation
Lab Packet
Spring 2027

Name: _____ **Section:** _____ **Date:** _____

Learning Objective 3.1: I can describe DSB-AM, DSB-SC, and SSB and identify each on a spectrum.
Learning Objective 3.2: I can implement an AM modulator and demodulator in GNU Radio and verify demodulated audio against the source.

This packet is the L6 Lab, in three parts, and you turn it in once, complete, before Lesson 7. Do **Part 1** on your own before the lab period: list the spectral lines you expect and the block settings you will need. **Part 2** is your own measurements, on your own laptop, recorded in class: turn the sliders and record what you see and hear. Do **Part 3** on your own after the lab: explain what changed and why, in words.

Grading. One submission, graded against Objectives 3.1 and 3.2 on the course's 1 / 0 scale, with revision allowed under course policy. Paste screenshots where a question asks for one.

No hardware. Every flowgraph in this lab is a simulation. Nothing transmits, and you need only your laptop and its speakers or headphones. Start with the volume low.

The flowgraphs are on the L6 lesson page: `L06-dsb-am.grc`, `L06-dsb-sc.grc`, and `L06-ssb.grc`. They run the Lesson 6 message on a carrier at $f_c = 10$ kHz, sampled at 48 kHz. **This lab uses its own message**: two cosine tones of equal amplitude, at 1.5 kHz and 2.25 kHz, scaled so that their sum peaks at exactly 1, on the same 10 kHz carrier. You set it in your own build and in each downloaded flowgraph.

Part 1: Pre-Lab (individual, before the lab period)

1. **Getting ready.** Work these for the lab's message before you build.

   (a) List the frequency of every line you expect on the DSB-AM spectrum, and say which one is the carrier.

Line (kHz)					

   (b) List the lines you expect for DSB-SC, USB, and LSB.

(c) Fill in the settings you will type into the two message Signal Sources, in your build and in each downloaded flowgraph.

Block	Setting	Value
Message Signal Source 1	Frequency (Hz)	
Message Signal Source 1	Amplitude	
Message Signal Source 2	Frequency (Hz)	
Message Signal Source 2	Amplitude	

Part 2: Measurements (your own laptop, in class)

2. **Build the DSB-AM flowgraph.** Start GRC with an empty canvas. Do not open `L06-dsb-am.grc`: build the transmitter and the envelope detector yourself, with a `samp_rate` of 48000, an `fc` of 10000, the message settings from Question 1(c), a QT GUI Range named `m` from 0 to 1.5, a frequency sink, a time sink comparing the detector output with the delayed envelope, and an Audio Sink.

   (a) Paste a screenshot of your flowgraph on the GRC canvas. Every connection must be black, not red.

   (b) Run it and confirm the lines you listed in Question 1(a). Then set m to each value below and read how many dB the 1.5 kHz tone's upper-sideband line sits below the carrier on the frequency sink.

m	0.25	0.5	1.0
Line below carrier (dB)			

   (c) Paste a screenshot of the time sink that compares the detector output with the delayed envelope at $m = 0.5$, and state whether they match.

3. Overmodulation. Keep your DSB-AM flowgraph running with the audio on.

(a) Raise m in steps of 0.05 and record the first value at which the detector output visibly departs from the envelope.

$m =$ ____

(b) Paste a screenshot at $m = 1.4$ and describe how the audio changes between $m = 0.5$ and $m = 1.4$.

4. DSB-SC. Open `L06-dsb-sc.grc`, set its two message Signal Sources to your Question 1(c) settings, and run it.

(a) Confirm the lines you listed in Question 1(b), and state the level of the frequency sink at the carrier frequency.

(b) With the LO phase at 0° the coherent receiver's peak is 1.0. Set the LO phase to each value below, read the peak off the time sink, and listen to the audio at each.

LO phase	30°	45°	60°	75°
Peak output				

(c) Switch Listen To from Coherent to Envelope, and describe the difference.

5. SSB. Open `L06-ssb.grc`, set its two message Signal Sources to your Question 1(c) settings, and run it.

(a) For each setting of the Sideband menu, record which lines remain and how far below them the suppressed sideband sits.

Sideband	Lines (kHz)	Suppression (dB)
USB		
LSB		

(b) With LSB selected, set the tuning error to $+120$ Hz. Paste the time sink and describe the audio.

(c) Find the largest tuning error, either sign, at which you cannot hear any pitch change from the original. This is the threshold of a noticeable shift, not of intelligibility.

Part 3: Writeup (individual, after the lab)

6. Analysis.

(a) Using your table in Question 2(b), describe what raising m does to the sideband lines and to the carrier line, and explain in words why the carrier does not change.

(b) Explain in words why an envelope detector recovers DSB-AM but not DSB-SC, and what the coherent receiver has that the envelope detector does not.

(c) A DSB-SC LO that is off in phase loses volume, while an SSB receiver that is off in frequency changes pitch. Using your measurements, explain which error a voice listener tolerates better, and why SSB receivers have a tuning knob instead of carrier recovery.

Documentation: _____