USAF ACADEMY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
LESSON 5 LAB - First Flowgraphs
Lab Packet
Spring 2027

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

Learning Objective 2.3: I can install GNU Radio and use GNU Radio Companion (GRC) to build, inspect, and run a basic flowgraph.
Learning Objective 2.4: I can capture a real RF signal using an SDR and interpret its time- and frequency-domain representations.

This packet is the L5 Lab, in three parts, and you turn it in once, complete, before Lesson 6. Do **Part 1** on your own before the lab period: install GNU Radio and work out the numbers your block settings fix. **Part 2** is your own measurements and observations, with your own laptop and PlutoSDR, recorded in class. Do **Part 3** on your own after the lab: explain what you saw.

Grading. One submission, graded against Objectives 2.3 and 2.4 on the course's 1 / 0 scale, with revision allowed under course policy. Paste screenshots where a question asks for one.

Receive only. Nothing in this lab transmits. The FM flowgraph uses only the PlutoSDR's receiver, and the tone flowgraph never leaves your laptop.

The flowgraphs and the Python script are on the L5 lesson page: `L05-tone.grc`, `L05-fm-spectrum.grc`, and `L05-psd.py`.

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

1. **Install and verify.** Install radioconda as the L5 lesson page describes, plug in your PlutoSDR, and run the commands below from the radioconda prompt.

   (a) Run `gnuradio-config-info --version` and record the version.

   version = _____

   (b) Run `iio_info -s` and record the device it reports. Then run the lesson page's `iio_attr` check, which must show 70 MHz to 6 GHz.

   device = _____

   (c) Open `L05-tone.grc` in GRC, run it, and paste a screenshot of the running flowgraph's window.

2. Numbers from your settings. Quick arithmetic from the block settings; you will check each on the screen at the bench.

(a) The tone flowgraph you build at the bench samples at $f_s = 48$ kHz. Work out where the frequency sink shows each tone.

Tone (kHz)	5	20	30	40	-35
Expected (kHz)					

(b) The FM flowgraph samples at 2.4 MS/s. Centered on 96.5 MHz, find the band the display shows.

band =

(c) Find the size of a 3 s recording at 2.4 MS/s.

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

3. **Build the tone flowgraph.** Start GRC with an empty canvas. Do not open `L05-tone.grc`: build it yourself from the Options block, a `samp_rate` variable of 48000, a QT GUI Range named `freq` from -72000 to 72000, a complex Signal Source, a Throttle, a QT GUI Time Sink, and a QT GUI Frequency Sink.

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

   (b) Set each tone with the slider and record where the spike appears.

Tone (kHz)	5	20	30	40	-35
Measured (kHz)					

4. The FM band. Connect the antenna to the PlutoSDR's RX port and look at the band in GNU Radio.

(a) Run `L05-fm-spectrum.grc`. Drag the center frequency slowly from 88 to 108 MHz and record the frequency of the tallest station you see.

station =

(b) Center the display on the station from part (a). Then tune across 88 to 108 MHz and record the three strongest stations: the frequency, the peak level on the display, and how wide each looks next to the others (narrow, medium, wide).

	Frequency (MHz)	Peak (dB)	Looks
Station 1			
Station 2			
Station 3			

(c) Uncheck DC tracking and find the DC spike. Tune so that a station sits on it, then tune 300 kHz away. Describe what moves and what does not, and what changes at the center when you check DC tracking again.

(d) With the strongest station on screen, set the gain to each value and record the noise floor away from any station. Mark the first setting where extra signals appear between stations.

Gain (dB)	0	20	40	60	71
Floor (dB)					
Spurs?					

5. Record and plot. Center the strongest station slightly off the DC spike and set the highest gain in your 4(d) table at which no spurs appeared.

(a) Enable the File Sink, run the flowgraph for about 3 s, stop it, and record the file size.

size = _____

(b) Run the plotting script with your center frequency, and paste the plot:

```
python L05-psd.py fm_capture.cfile --fs 2.4e6 --fc <center Hz>
```

Part 3: Writeup (individual, after the lab)

6. Analysis.

(a) Compare your measured aliases in Question 3(b) with your answers in Question 2(a). Choose one tone from your table that moved, and explain why it and the frequency where it appeared produce the same samples at 48 kHz.

(b) Using your table in Question 4(d), describe in words what happened as you raised the gain from 0 to 71 dB: to the noise floor, to how far the strongest station stood above it, and to the space between stations.

(c) State the gain you would use to receive weak stations in this room, and justify it from your table in Question 4(d).

Documentation: _____