USAF ACADEMY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
LESSON 8 LAB - FSK
Lab Packet
Spring 2027

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

Learning Objective 4.1: I can describe FSK modulation and implement an FSK transmitter and receiver in GNU Radio.

This packet is the L8 Lab, in three parts, and you turn it in once, complete, before Lesson 9. Do **Part 1** on your own before the lab period: run the link flowgraph, read its display, and work out the block settings you will use at the bench. **Part 2** is your own measurements, on your own laptop, recorded in class. Do **Part 3** on your own after the lab: explain what you saw and answer the analysis questions.

Grading. One submission, graded against Objective 4.1 on the course's 1 / 0 scale, with revision allowed under course policy. Paste screenshots where a question asks for one.

No hardware, no transmitting. Every flowgraph in this lab runs on your laptop. The Channel Model block stands in for the air, and nothing in this lab transmits.

The flowgraphs are on the L8 lesson page: `L08-fsk-tx.grc` and `L08-fsk-link.grc`. Every number below assumes the flowgraphs' settings: $f_s = 32$ kHz, 32 samples per symbol, and a line of 40 characters and a newline, 41 bytes.

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

1. **Run the link.** Open `L08-fsk-link.grc` in GRC and run it with the sliders at their defaults.

   (a) After about 20 s, record the Lines label.

   (b) Paste a screenshot of the running flowgraph's window.

2. Settings and readings. Question 3 checks the bandwidth against your spectrum.

(a) Fill in the transmitter and receiver settings for each deviation.

Δf	sensitivity k	demod gain g	bandwidth B	LPF cutoff
1500 Hz				
2000 Hz				

(b) Run `L08-fsk-link.grc`. On its spectrum, read how far the two tones stand above the noise floor with the noise slider at 0.5, then at 1.0. Describe what the eye diagram does between the two.

Noise voltage	0.5	1.0
Tones above floor (dB)		

(c) Each line is a packet: a 64-bit access code, a 32-bit header, and the 41 bytes of the line, its 40 characters and a newline. Find the bits per packet, the time per packet, and the number of packets in 30 s.

bits =

time =

in 30 s =

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

3. **Build the transmitter.** Start GRC with an empty canvas. Do not open `L08-fsk-tx.grc`: build it yourself as the lab page lists, from a Vector Source of message bytes, Unpack K Bits, Chunks to Symbols, Repeat, Frequency Mod, a Throttle, and a QT GUI Frequency Sink, with a QT GUI Range named `dev`.

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

   (b) Run it and record the frequencies of the two spectral peaks at each deviation. Paste a screenshot of the spectrum at 2000 Hz, and compare its width at each deviation with your bandwidth B from Question 2(a).

Deviation (Hz)	1500	2000
Peaks (kHz)		

4. Noise. Run `L08-fsk-link.grc` with the frequency offset at 0. For each noise voltage, set the slider, wait about 30 s, and record the Lines label. The count restarts each time a slider moves. Sent is the time divided by your packet time from Question 2(c).

(a) Fill in the table.

σ	0.5	0.8	1.0	1.2	1.5	2.0
Time (s)						
Sent						
Received						
Correct						

(b) Paste a screenshot of the eye diagram at $\sigma = 1.2$, and describe how it differs from the eye at $\sigma = 0.5$.

(c) Set the noise back to 0.5 and raise it in steps of 0.1 until a wrong line appears. Record that noise voltage, and compare the tones' height above the floor there with your reading at 1.0 in Question 2(b).

σ =

vs. 2(b):

5. Frequency offset. Set the noise voltage back to 0.5. For each offset, set the slider, wait about 20 s, and record the two levels of the eye diagram and the Lines label.

(a) Fill in the table.

Offset (Hz)	0	300	600	800	1000
Levels					
Lines					

(b) Fill the $\Delta f = 1000$ Hz row from Question 4(a) ($\sigma = 1.2$) and from one run at $\sigma = 0.5$ and an offset of 1200 Hz before changing `dev`. Then stop the flowgraph and change the `dev` variable to 2000; the transmitter, the filter, and the demodulator all follow it. Run it at each setting below for about 20 s and record the Lines label.

Setting	$\sigma = 1.2$, offset 0	$\sigma = 0.5$, offset 1200 Hz
$\Delta f = 1000$ Hz		
$\Delta f = 2000$ Hz		

Part 3: Writeup (individual, after the lab)

6. Analysis.

(a) From your table in Question 4 and your screenshots, describe in words what the eye and the received text did as you raised the noise from 0.5 to 2.0. Explain why a small turn of the slider takes the link from clean text to no text, and what that means for the link margin of Lesson 2.

(b) Take the largest offset at which your link still delivered correct lines in Question 5(a). Convert it to parts per million at 915 MHz, and explain what it says about running this link over the air between two SDRs whose crystals are accurate to a few ppm.

(c) Recommend a deviation of 1000 or 2000 Hz for this link, and justify it from your measurements in Questions 4 and 5. Name what the choice gives up.

Documentation: _____