

**CS4390/5390 Applied Numerical Computing for Multimedia Applications**  
**Spring 2025. Homework Assignment 2**  
**Due: 04/18/2025 11:59PM MDT**  
**Individual Assignment**

In class, we see the basics of generating sine waves in Digital Signal Processing and we have shortly discussed Frequency Shift Keying as a way of transmitting digital information over an analogue channel.

For this second homework assignment, your task is to:

- Set up the given boilerplate code environment, as it is available in the git repository. This step is detailed in Section 1.
- Document yourself in more detail how FSK modulation works, typically by reading<sup>1</sup> the Wikipedia page at [https://en.wikipedia.org/wiki/Frequency-shift\\_keying](https://en.wikipedia.org/wiki/Frequency-shift_keying) and/or [https://es.wikipedia.org/wiki/Modulaci%C3%B3n\\_por\\_desplazamiento\\_de\\_frecuencia](https://es.wikipedia.org/wiki/Modulaci%C3%B3n_por_desplazamiento_de_frecuencia).
- Implement FSK modulation to transmit a string of bytes, with 1 start bit, 1 stop bit and 8 data bits, no parity bit. This step is detailed in Section 2.
- Write a short report<sup>2</sup> on your implementation strategy, the issues encountered etc.

Your deliverables are:

- A fully working `fsk_sender.py` Python program, committed to a branch of the git or submitted in the form of a code archive by email to `utep-numerical@christoph-lauter.org`.
- A PDF report with your testing strategy, description of bugs etc. You can submit this report by email to `utep-numerical@christoph-lauter.org`.

## 1 Code Setup

Clone the git available at <https://gitlab.com/cquirin/utep-numerical-computing-2025>, ideally on a Linux system<sup>3</sup>. Refer to the internet for HowTos on git cloning. Document the steps in your report. Locate the `fsk_sender.py` boilerplate program. Try to run the program. This step may require that you install additional Python packages on your system.

## 2 FSK Modulation

Start by creating a branch of yours in the git. Refer to the internet for HowTos on git branches. You should name your branch with your name.

Complete the code in the boilerplate code file that you find in the git, so that you obtain a fully working FSK sender program.

The program does the following:

- It starts by checking that it got a string as a command line argument. It converts this string to a byte-sequence.
- It sends 1000 milliseconds of a 1650Hz tone.

---

<sup>1</sup>and understanding

<sup>2</sup>In the format of a PDF document. No Microsoft Word, resp. convert to PDF in the end.

<sup>3</sup>If you need access to a Linux system but you cannot find any, ask your instructor. He has a system available with access over the internet.

- It sends the byte-sequence corresponding to the text in FSK modulation. The transmission parameters are as follows:
  - Sampling frequency: 8000 Hz
  - Frequency to transmit a zero: 1850 Hz
  - Frequency to transmit a one: 1650 Hz
  - Number of bits transmitted per second (Baud-Rate): 50
  - Start-Bit: 1 start-bit, always a zero
  - Stop-Bit: 1 stop-bit, always a one
  - Data-Bits: 8 bits, transmitted LSB first
  - Parity-Bits: none
- After sending the byte-sequence, the program sends 1000 milliseconds of a 1650 Hz tone and then terminates.

Be sure to understand how to use the Goertzel algorithm. The use of math functions such as `cos` is permitted only for the precomputation of constants.

Document your code, your software development strategy, your reasoning behind the code and the issues you encounter in your report.

Do not forget to commit your work to the git and to push your branch back to origin<sup>4</sup>.

---

<sup>4</sup>If, really, you cannot figure out git well enough, you can submit an archive by email.