

National Taiwan University
Fourier transform and Fourier optics
Project: Audio Signal Processing (Spring 2025)

Due: 2025/5/2

Please write a report to answer the following questions and upload it with your code to NTU COOL.

Problem 1. (10 pts)

Record your own voice and create an audio file about 10 seconds in length. Plot the signal in the time domain. Be sure to label the axes with units.

Problem 2. (10 pts)

What was the sampling rate? Reduce the sampling rate numerically and compare the signals with different sampling rates in the time domain. Describe what you observe.

Problem 3. (10 pts)

How many bits were used to quantize the time-domain signal? Reduce the bits for quantization numerically and compare the signals with different quantization in the time domain. Describe what you observe.

Problem 4. (20 pts)

Perform fast Fourier transform and plot the signal in the frequency domain. Be sure to label the axes with units. Describe the energy distribution in the spectrum. What frequency components are the signal? What are the noise?

Problem 5. (10 pts)

Double the length of the signal by the zero padding technique in the time domain. Compare the signal spectrum with and without zero-padding. Describe what you observe. Is the frequency resolution increased?

Problem 6. (20 pts)

Perform short-time Fourier Transform and show the signal in a spectrogram (a frequency vs time plot). Describe how you window the signal and estimate the corresponding time resolution and frequency resolution.

Problem 7. (20 pts)

Try to apply a filter to reduce the noise. Describe your filter design. Plot the impulse response and transfer function of your filter. Compare the signal before and after filtering in the time domain and the frequency domain. Play the filtered signal and describe what you observe.

Problem 8. (optional 20 pts)

Try to change the pitch of your voice. Describe how you do it and what you observe.