Audio Sampling and Quantization Assignment:

Objective: To understand the impact of sampling rate and bit depth on the quality and file size of audio recordings.

Steps:

1. Download a short audio clip using the internet.

2. Sample the analog signal at different frequencies (e.g., 44.1 kHz, 22 kHz, and 11 kHz).

3. Quantize each sampled signal to different bit depths (e.g., 16-bit, 8-bit).

4. Compare and analyze the impact of sampling rate and bit depth on the quality and file size of the audio.

Procedure:

1. **Sampling at Different Frequencies:**

   Import the recorded audio clip into a DAW.

   Create three copies of the audio clip.

   Sample each copy at different frequencies (44.1 kHz, 22 kHz, and 11 kHz).

   Maintain the original duration of the audio clip for consistency.

2. **Quantization at Different Bit Depths:**

   For each sampled version, create copies and quantize them to different bit depths (e.g., 16-bit, 8-bit).

   Use appropriate tools in your DAW or dedicated audio processing software for quantization.

3. **Analysis:**

Compare the original and processed audio clips at different sampling rates and bit depths.

Listen to each version carefully and note any audible differences in terms of clarity, detail, and distortion.

Use analysis tools to inspect the spectrograms or frequency content of the audio clips.

Document any observed changes in the audio quality.

4. **File Size Comparison:**

Record the file sizes of each version.

Analyze the correlation between sampling rate, bit depth, and file size.

Discuss the trade-offs between higher quality (higher sampling rate, higher bit depth) and larger file sizes.

5. **Reflection:**

Write a reflection on the impact of sampling rate and bit depth on audio quality.

Discuss the practical considerations when choosing sampling rates and bit depths in different audio recording scenarios.

Reflect on how the exercise relates to real-world applications, such as audio production and streaming.

7. Submission:

Submit a report including your recorded audio clips, quantized versions, file sizes, spectrogram images, and a written analysis of your findings.

This exercise provides a hands-on experience in understanding the fundamental concepts of audio sampling and quantization, helping students grasp the relationship between these parameters and the resulting audio quality.

Digital Audio Workstation (DAW) software

There are several free Digital Audio Workstations (DAWs) available that provide powerful tools for audio recording, editing, and production. Here are a few examples:

Audacity:

Platform: Windows, macOS, Linux

Features: Multi-track audio editing and recording. Support for various file formats. Built-in effects and plugins. Simple and user-friendly interface.

Except Audacity, there are:

LMMS (Linux MultiMedia Studio): Platform: Windows, macOS, Linux

Ardour: Platform: Linux, macOS

Cakewalk by BandLab: Platform: Windows

Tracktion T7: Platform: Windows, macOS, Linux

Waveform Free: Platform: Windows, macOS, Linux

Install required plugins for sampling and quantization if required.

Simple steps to guide you (Here's how you can do it):

1. Sampling (Changing Sample Rate & Bit Depth)

Audacity allows you to change the sample rate and bit depth without additional plugins:

- **Changing Sample Rate**:

    - Go to **Project Rate (Hz)** in the lower-left corner and select the desired sample rate (e.g., 44.1 kHz, 48 kHz, or 96 kHz).

    - Alternatively, go to **Tracks → Resample** and enter your desired rate.

- **Changing Bit Depth**:

    - Go to **Edit → Preferences → Quality**.

    - Adjust **Default Sample Format** (16-bit, 24-bit, or 32-bit float).

2. Quantization (Bit Depth Reduction)

Audacity does not explicitly label this process as quantization, but you can control it when exporting audio:

- Go to **File → Export → Export Audio**.

- Choose a format like **WAV** or **FLAC**.

- Select the **desired bit depth** (16-bit, 24-bit, etc.) under "Format Options."

- If reducing bit depth, you may need to apply **dither** (found in **Edit → Preferences → Quality**) to reduce quantization noise.