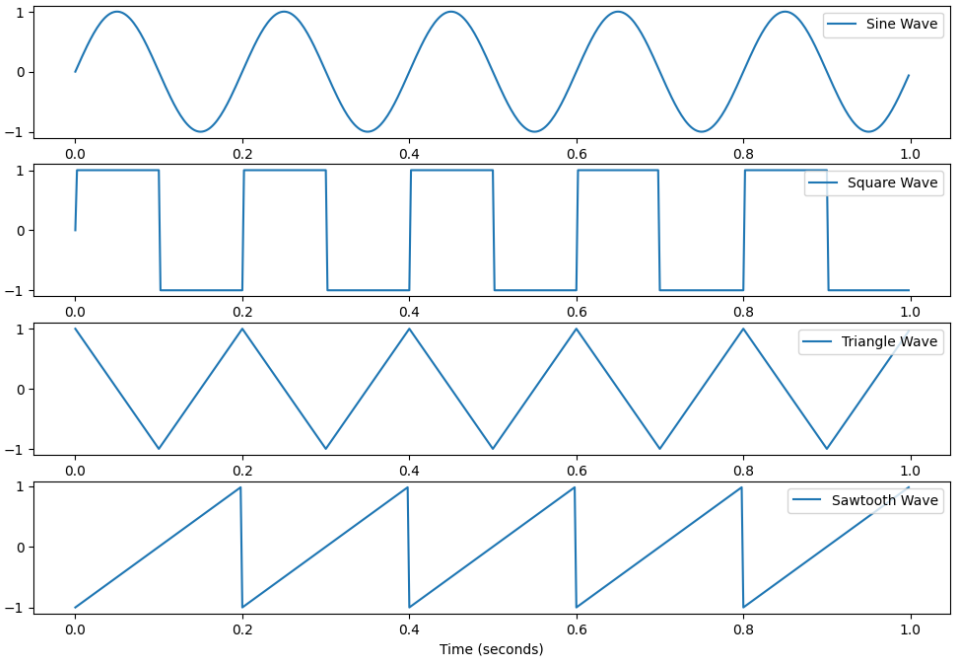
Module 2: Synthesis Techniques

This module explores the core concepts of sound synthesis, a fundamental aspect of audio engineering. Students will learn about the different types of synthesizers, basic waveforms, and envelope controls, along with an introduction to modulation techniques and their applications in modern music production.

➢ Linear Synthesizer

1. **Basic Waveforms**
    - **Sine Wave**: Purest form of waveform, fundamental to other sounds. It has a smooth, periodic oscillation.
    - **Square Wave**: Has a rich, hollow tone; contains odd harmonics. It switches abruptly between high and low amplitude.
    - **Triangle Wave**: Similar to the sine wave but with a linear rise and fall that gives it a sharper tone. Contains only odd harmonics.
    - **Sawtooth Wave**: Contains both odd and even harmonics; has a buzzy quality. It rises linearly but drops abruptly.

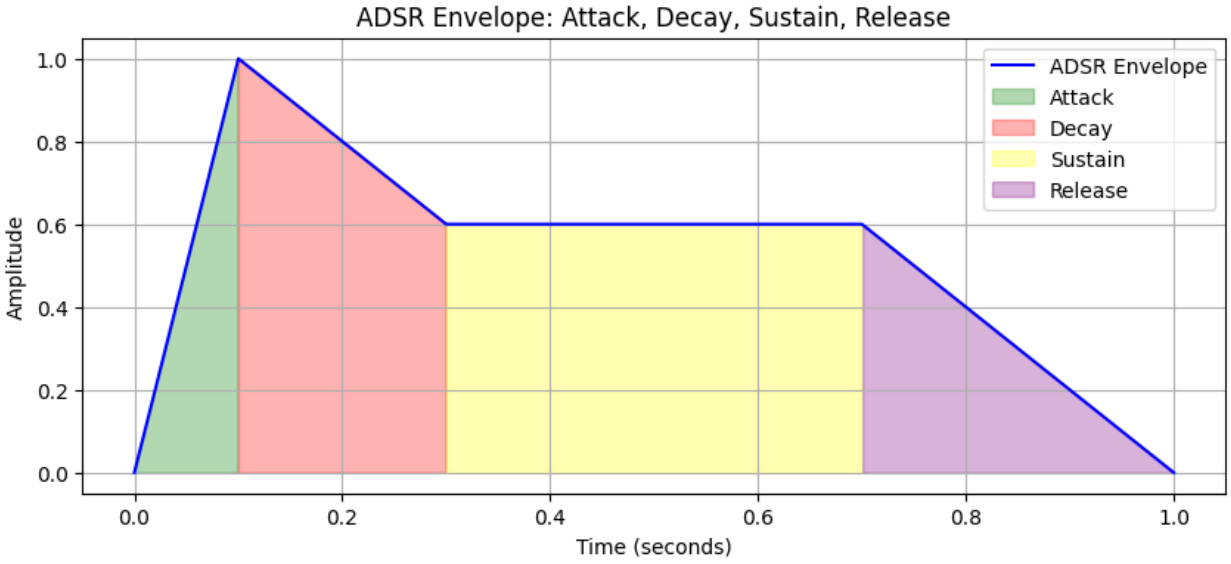
Visualizing Basic Waveforms with Python



2. **ADSR Envelope: Attack, Decay, Sustain, Release**
    - **Attack**: How quickly the sound reaches its maximum level after being triggered.
    - **Decay**: How quickly the sound drops to the sustain level after the initial peak.
    - **Sustain**: The level during the main sequence of the sound's duration, until the key is released.
    - **Release**: How quickly the sound fades when the key is released.

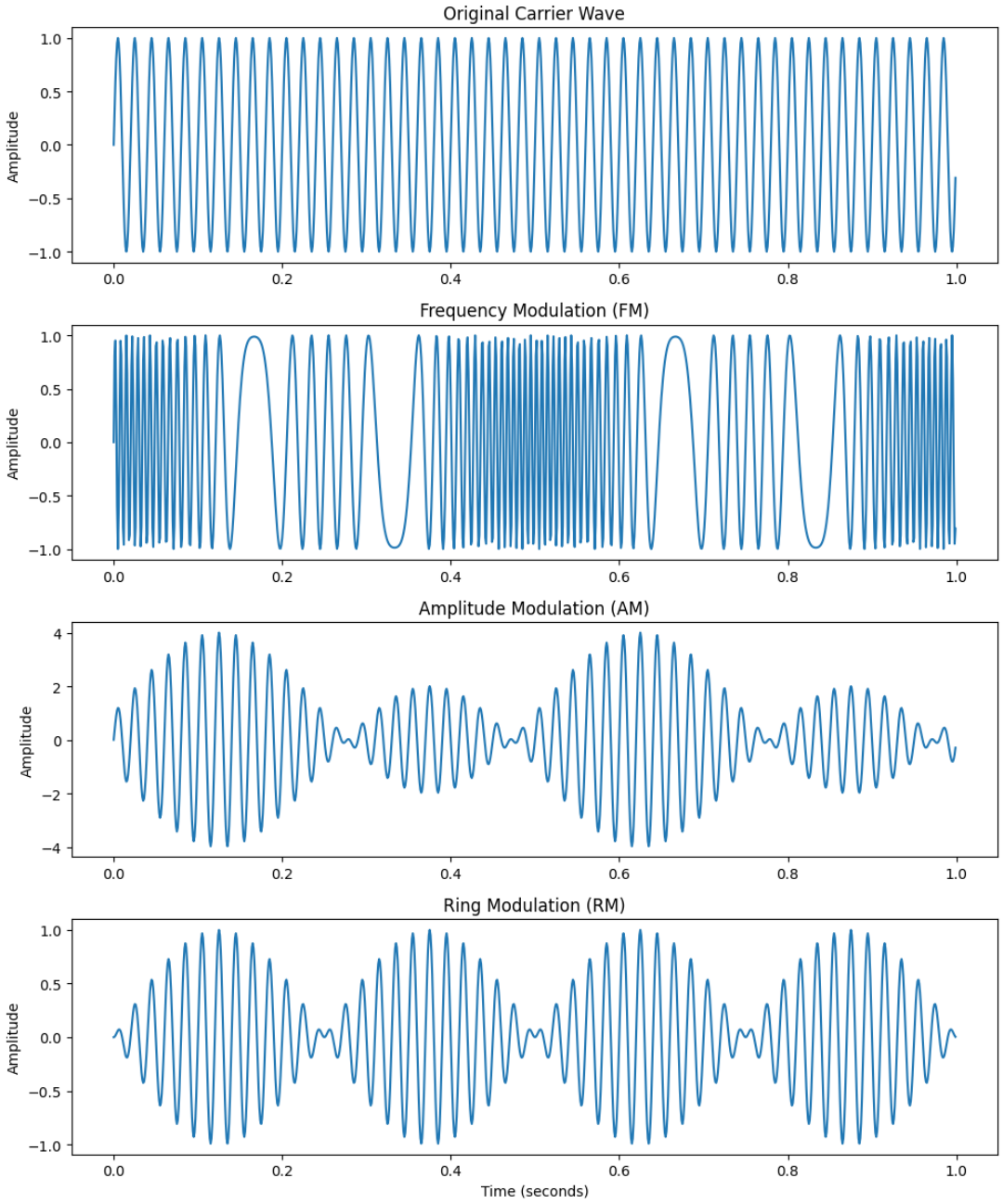
In the graph below, each phase of the ADSR (Attack, Decay, Sustain, Release) envelope is clearly marked with different colors, making it easy to identify:

- **Attack (Green)**: The quick rise at the beginning where the sound reaches its peak. This phase is short and steep.
- **Decay (Red)**: Immediately following the attack, the amplitude decreases to the sustain level. It's a relatively swift drop compared to the attack.
- **Sustain (Yellow)**: This level phase maintains a constant amplitude as long as the note is held. It is visually represented by a flat, extended line.
- **Release (Purple)**: The final phase where the amplitude fades back to zero after the note is released. This tail-off is also quick and concludes the sound's envelope.



➢ Non-linear Synthesizer

1. **Introduction to Modulation Techniques**
    - **Frequency Modulation (FM)**: Modulating the frequency of a waveform with another waveform, resulting in complex harmonic content.
    - **Amplitude Modulation (AM)**: Modulating the amplitude of the carrier wave with another waveform, used to create tremolo effects.
    - **Ring Modulation (RM)**: A type of amplitude modulation but with the modulating signal subtracted as well as added to the carrier.



2. **Practical Uses of Non-linear Synthesis in Modern Music Production**
    - **Texture and Depth**: Non-linear synthesizers can add rich textures and depth to music, making it more vibrant and expressive.
    - **Sound Design**: Widely used in sound design to create unique sounds for movies, games, and electronic music.
    - **Dynamic Effects**: Employing modulation techniques can dynamically alter the timbre of sounds during a performance or recording.