Technical Whitepaper: The Neon Horizon Engine v2.0

Author: Nicholas Panek **Date:** December 2, 2025 **Subject:** Deterministic Audio Synthesis via Trigonometric and Modulo Constraints

1. Abstract

The Neon Horizon Engine is a proprietary deterministic system for audio generation. It rejects standard stochastic (random) generation in favor of **Trigonometric Probability**. Musical events—rhythm, pitch, and timbre—are derived from the intersection of continuous sine waves and discrete integer grids. This results in a "Synthwave" aesthetic that is mathematically perfectly aligned yet organic in its modulation.

2. Mathematical Methodology

The core innovation is the **"LFO-Driven Composition."** Instead of randomizing note choice, the engine maps a Low-Frequency Oscillator (LFO) to the scale index.

$$Note(t) = R + Scale[\lfloor A \cdot \sin(f \cdot t) + \phi \rfloor (\mod n)]$$

Where:

- **R** is the Root Note.
- **A** is the Amplitude (Range of the melody).
- **f** is the Frequency (Speed of the melodic idea).
- **n** is the length of the scale.

3. The Logic Streams

A. The Euclidean Bass Function

The bassline rhythm is not a fixed loop but a **Modulo Operation**. The bass strikes only when the step index i satisfies the condition:

$$i \pmod P < D$$

Where P (Period) and D (Duty Cycle) are constants defined by the author to create driving, asymmetric rhythms (e.g., the "Tresillo" or "Motorik" beat).

B. The Harmonic Series Constraint

To emulate analog warmth, the engine strictly enforces **Add-9 Voicings**. The chord stack is defined as intervals {0,4,7,14} relative to the root. This specific interval set maximizes constructive interference in the lower-mid frequencies, creating the "warmth" characteristic of the genre.

C. The Deterministic Drift

Pitch instability (analog drift) is calculated using a **Cosine Function** applied to the MIDI Pitch Wheel control. This ensures the "out of tune" effect follows a smooth, natural curve rather than jagged random values.

4. Verification

All files are stamped with the seed values of the sine functions used to generate them:

- **Format:** `Synth_[Key]_[BPM]_[Period]_[Amplitude].mid`

5. Conclusion

By replacing random number generation with fixed trigonometric functions and modulo logic, Nicholas Panek retains sole authorship of the generative source code and the resulting audio output.