

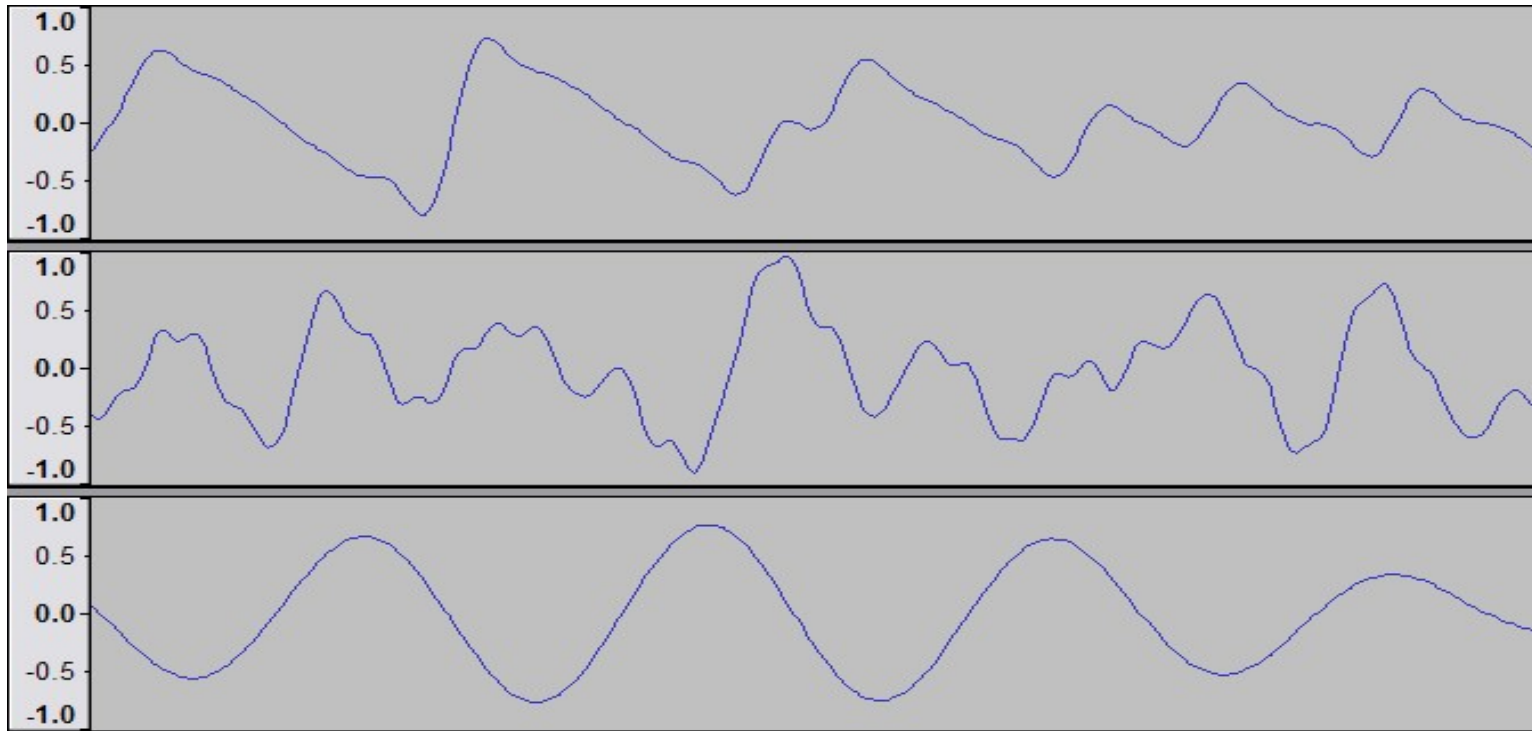
Victor Shepardson

**Developing a Versatile Audio Synthesizer
With Digital Oscillators**

**TJHSST Computer Systems Lab
2009-10**

Sound and its Digital Representation

Waveforms:



Audacity.sourceforge.net

Pulse Code Modulation:

signal amplitude at regular intervals represented by a binary integer

Methods of Synthesis

-Subtractive

- Early analog machines
- Oscillator and filter stages

-Sampling

- Very effective at imitation
- Light on processing
- Memory needed for samples

-Additive

-FM

Additive Synthesis

-Fourier

-Periodic functions can be decomposed to spectra:

Amplitude, frequency and phase of sine waves

-Summing Oscillators

-Fourier Transforms

FM Synthesis

-Frequency Modulation:

-One audio band signal modulates another

-Analog: hard

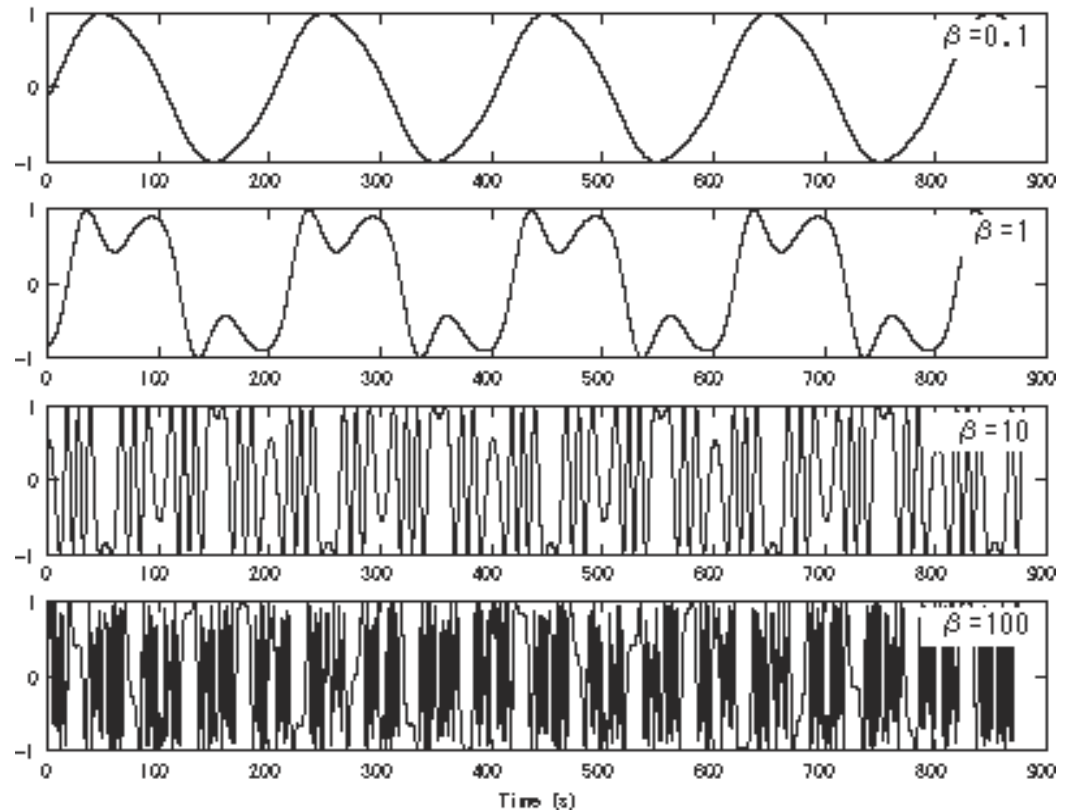
-Digital: easy

-Digital Oscillators

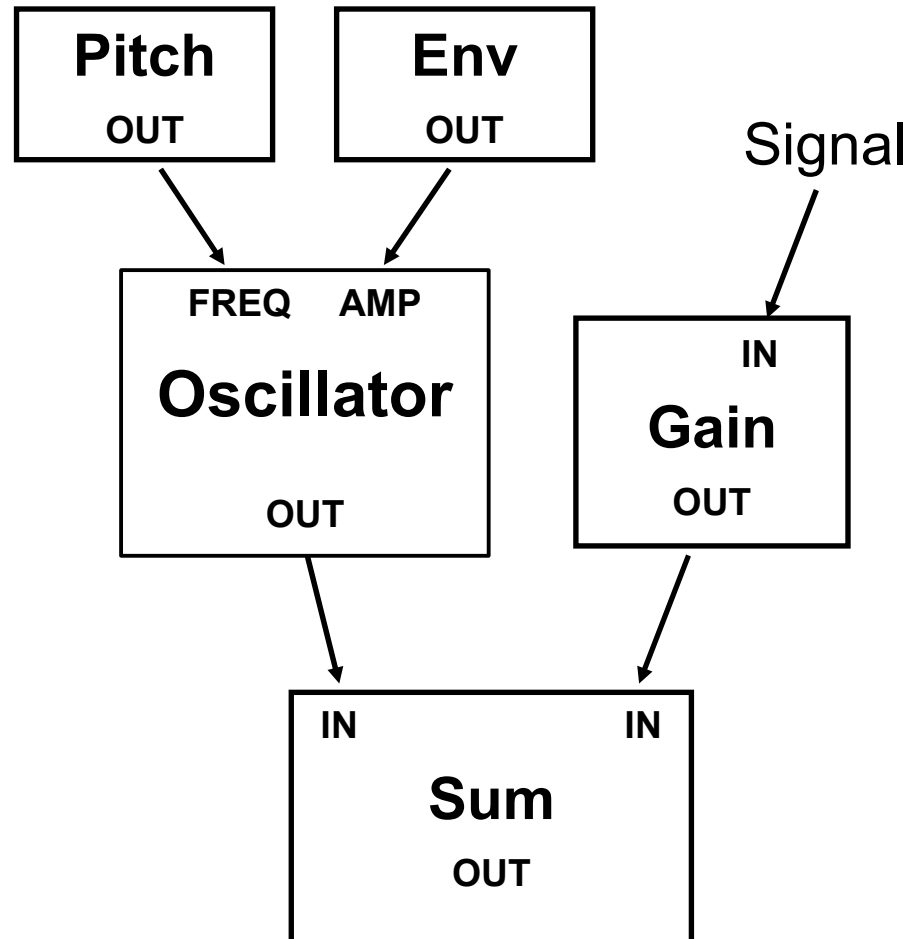
-Powerful Controls:

-M:C ratio

-Modulation Index



Modular Synthesizer



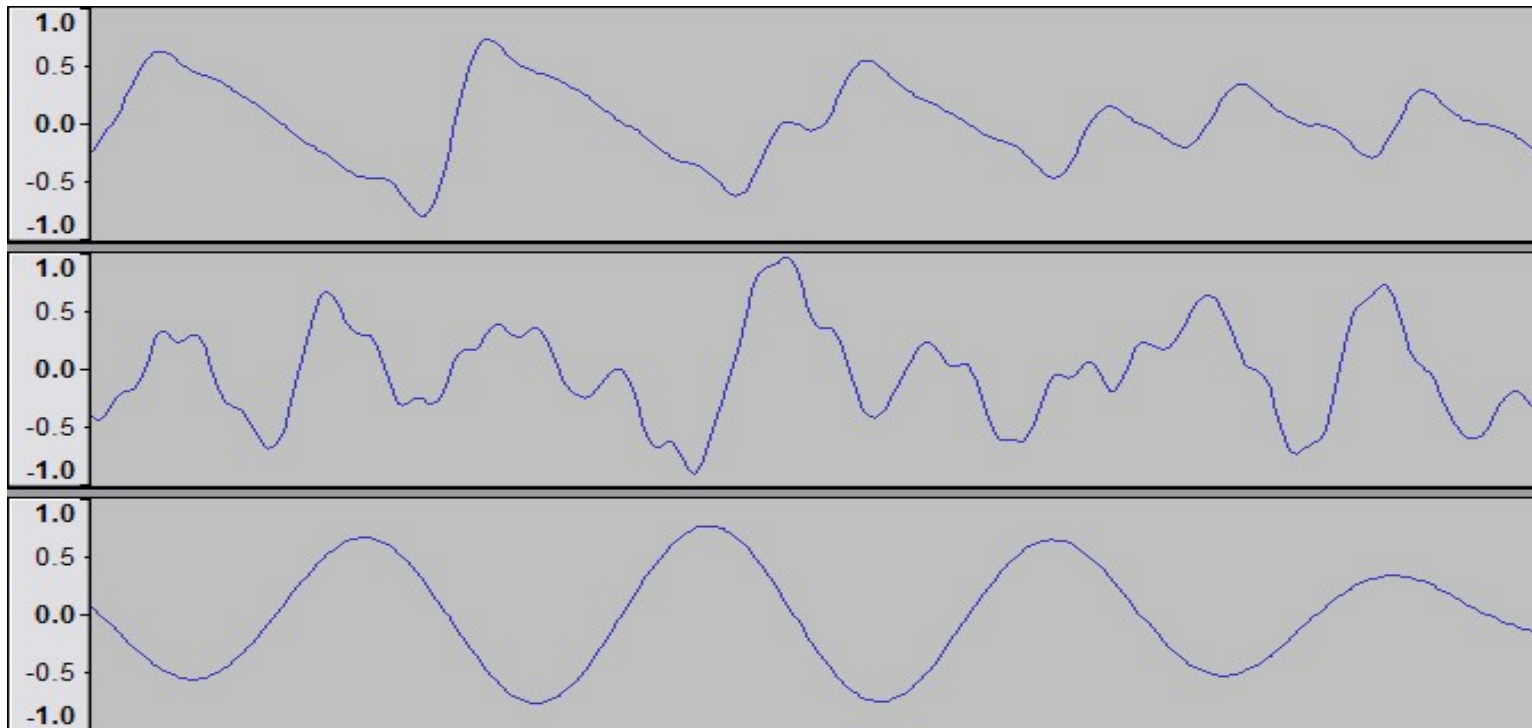
Oscillators

Stored:

- Waveform
- Phase

Inputs:

- Frequency
- Amplitude



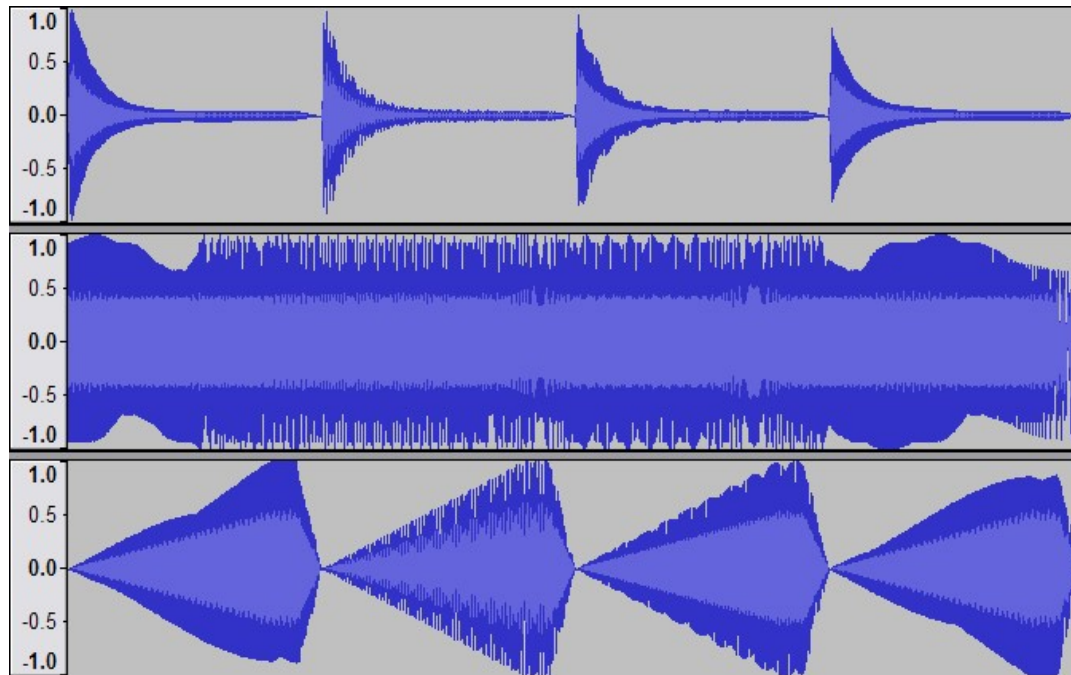
Pitch and Envelope objects

Pitch:

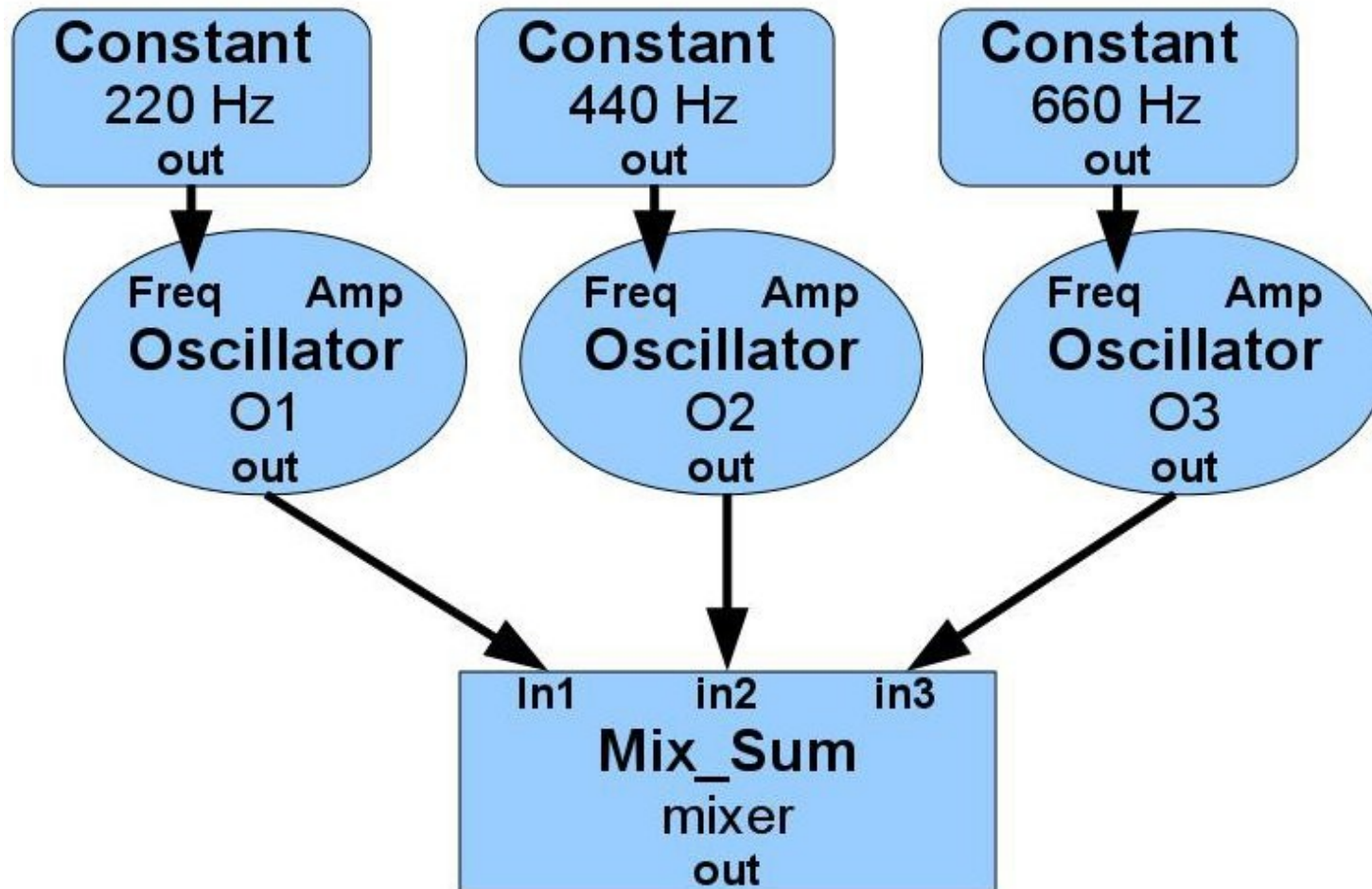
-Take notation, output instantaneous frequency in Hz

Envelope

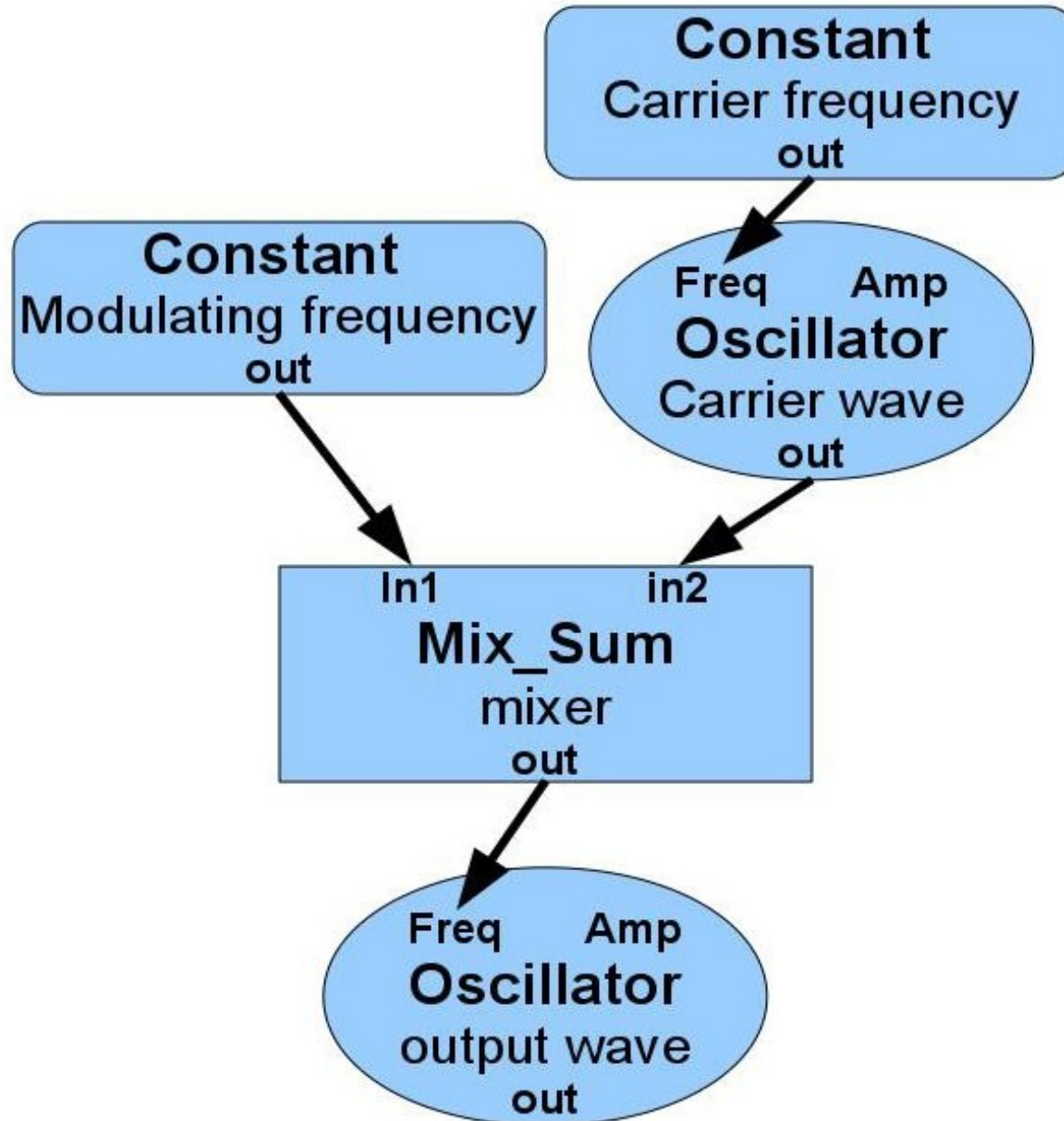
-Take notation/ ADSR parameters, output amplitude



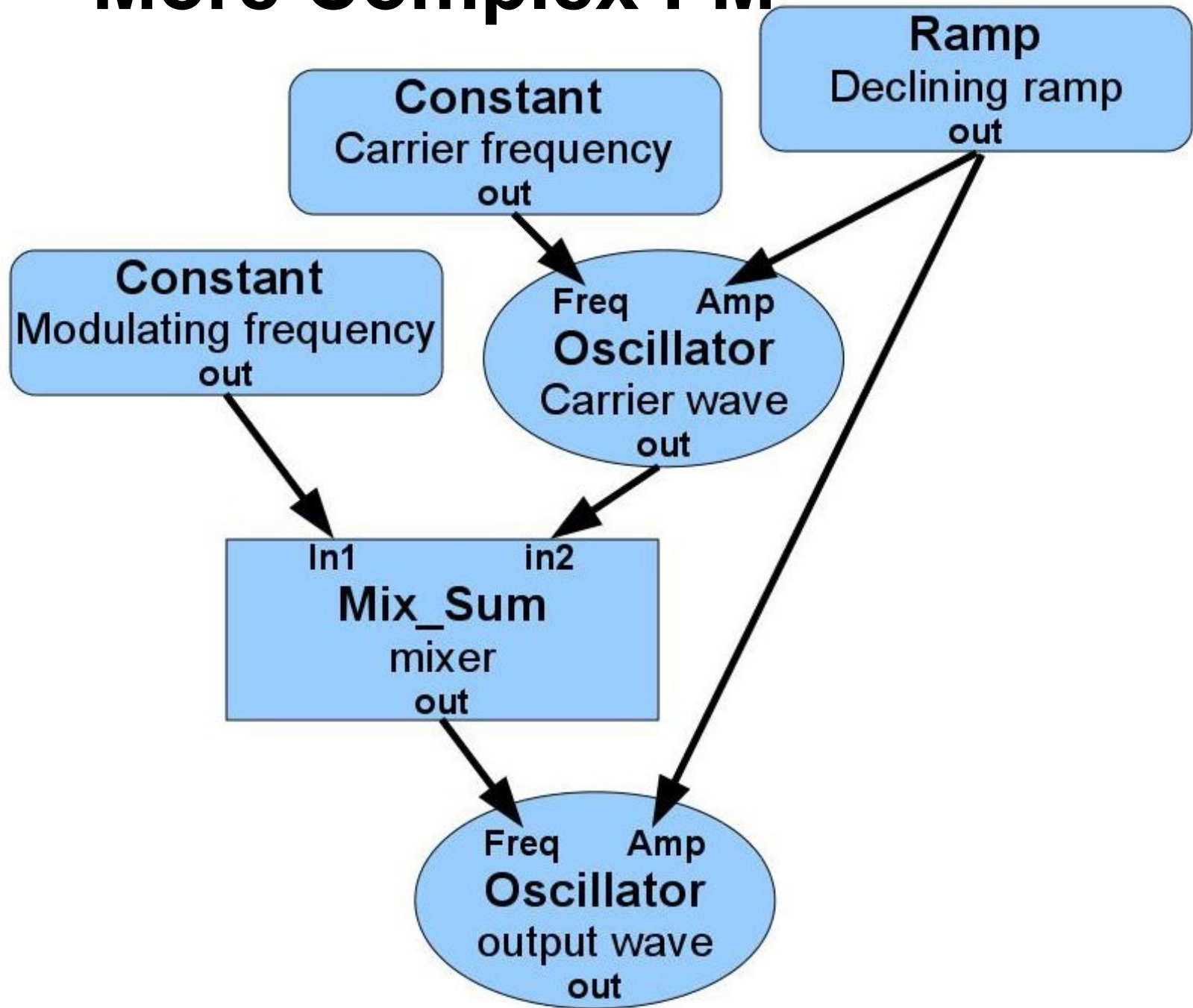
Implementing Additive Synthesis



Implementing FM



More Complex FM



References

Chowning, J., "The Synthesis of Complex Audio Spectra by Means of Frequency Modulation". *Journal of the Audio Engineering Society* 21(7), pp. 526-534, 1973.

Moore, R., *Elements of Computer Music*, Prentice Hall, Englewood Cliffs, NJ, 1990.

Valsamakis, N. and Miranda, E. R., "Iterative sound synthesis by means of cross-coupled digital oscillators", *Digital Creativity* 16(2), pp. 79-92, 2005.