025:250 COMPOSITION: ELECTRONIC MEDIA I

Calculating harmonic frequency from fundamental frequency and harmonic number; calculating harmonic number from fundamental frequency and harmonic frequency; calculating fundamental frequency from adjacent harmonics; calculating harmonic amplitude from waveshape type and amplitude and harmonic number; calculating harmonic frequencies of frequency-modulated periodic sounds.

Harmonic frequency from fundamental frequency and harmonic number

Example: If a sound has a fundamental frequency f of 230 Hz, what is the frequency f_5 of its 5th harmonic?

a) f = 230 Hz

b) $f_5 = 5(230\ Hz)$

c) $f_5 = 1150$ Hz

Harmonic number from fundamental frequency and harmonic frequency

Example: If a sound has a fundamental frequency f of 1200 Hz, what is the harmonic number N of the harmonic frequency $f_N = 8400$ Hz?

a) f = 1200 Hz

b) $f_N = 8400$ Hz

c) $N = f_N/f$

d) N = 8400 Hz/f Hz

e) N = 8400 Hz/1200 Hz

f) N = 7

Fundamental frequency from adjacent harmonics

Example: If harmonic $f_N = 1600$ Hz and harmonic $f_{(N+1)} = 2000$ Hz, what is the fundamental frequency f?

a) $f_N = 1600$ Hz

b) $f_{(N+1)} = 2000$ Hz

c) $f = f_{(N+1)} - f_N$

d) f = 2000 Hz - 1600 Hz

e) f = 400 Hz

Harmonic amplitudes of a sawtooth wave

Example: If a sawtooth wave has an amplitude A of 12000, what is the amplitude A_3 of its 3rd harmonic?

a) $A = 12000$

b) $A_N = A/N$

c) $A_3 = 12000/3$

d) $A_3 = 4000$

Harmonic amplitudes of odd harmonics of a square wave

Example: If a square wave has an amplitude A of 12000, what is the amplitude A_3 of its 3rd harmonic?

a) $A = 12000$

b) $A_N = A/N$ if $N = \{1, 3, 5, ...\}$

c) $A_3 = 12000/3$

d) $A_3 = 4000$

Harmonic amplitudes of even harmonics of a square wave

Example: If a square wave has an amplitude A of 12000, what is the amplitude A_4 of its 4th harmonic?

a) $A = 12000$

b) $A_N = 0$ if $N = \{2, 4, 6, ...\}$

c) $A_4 = 0$

Upper and lower sidebands in simple ratio sine wave frequency modulation

Let sine wave 1 be modulated by sine wave 2. Sine wave 1 is called the carrier and has a frequency c. Sine wave 2 is called the modulator and has a frequency m.

Example: If a sine wave carrier frequency c = 300 Hz is modulated by a sine wave modulator frequency m = 100 Hz, what are the frequencies of the Nth = 3rd order upper and lower sidebands? List all the frequencies, including the carrier, in ascending order to see the resulting harmonic structure of the resultant tone.

a) $c = 300$ Hz

b) $m = 100$ Hz

c) $N = 3$

d) Nth order upper sidebands $= c + m, c + 2m, \ldots, c + Nm$

e) 3rd order upper sidebands $= 300$ Hz $+ 100$ Hz, 300 Hz $+ 2(100)$ Hz, 300 Hz $+ 3(100)$ Hz

f) 3rd order upper sidebands $= 300$ Hz $+ 100$ Hz, 300 Hz $+ 200$ Hz, 300 Hz $+ 300$ Hz

g) 3rd order upper sidebands = 400 Hz, 500 Hz, 600 Hz

h) Nth order lower sidebands = c - m, c - 2m, . . . , c - Nm

i) 3rd order lower sidebands = 300 Hz - 100 Hz, 300 Hz - 2(100)Hz, 300 Hz - 3(100)Hz

j) 3rd order lower sidebands = 300 Hz - 100 Hz, 300 Hz - 200 Hz, 300 Hz - 300 Hz

k) 3rd order lower sidebands = 200 Hz, 100 Hz, 0 Hz

l) Harmonic series: 100 Hz, 200 Hz, 300 Hz, 400 Hz, 500 Hz, 600 Hz