KAAP686 Mathematics for Biomechanics

Intro to Signals

Vocabulary of signals

Amplitude

Instantaneous

Peak-to-peak

Power

Actual power is work per unit time (watts, hp). If signal is a voltage connected to a resistance R, the power is

P(t) = V(t)\*I(t) = V(t)\*V(t) / R = V2(t) / R, where R is a constant.

This electrical idea has been generalized to signals of any type, by using “power” to refer to the square of a signal (or the mean of the square of a signal).

Average power (for a time T)

Root mean square (RMS) value of signal:

Amplitude of a constant signal that’d have same (average) power as the measured (non-constant) signal. Turns out that:

*x*RMS = square root of the mean of the square of *x(t)*.

To find RMS, first square, then average, then take square root.

Decibels

Logarithmic measure of relative signal intensity

1 Bel = factor of 10 difference in power

L2 – L1 (in Bels) = log10(P(*x2*)/P(*x1*))

1 Bel = 10 deciBels

L2 – L1 (in deciBels) = 10\*log(P(*x2*)/P(*x1*))

Power proportional to signal squared

P(*x2*)/P(*x1*) = *x22(t) / x12(t) =* (*x2/x1*)*2 =* (*A2/A1*)*2*

L2 – L1 (dB) = 10\*log(*A2/A1*)*2* = 20\*log(*A2/A1*)

Rectification

Full wave rectification: Taking absolute value of a signal. Useful in circuits when need power from a zero-mean signal.

Half wave rectification: keep the positive parts of the signal; set it to zero when it is below zero. Simplest kind of rectification to implement in an analog circuit.

In-class ?s:

RMS of: +/- 1V square wave, +/- 1V triangle

dB differences between a reference signal and a signal with: half the power, half the amplitude, 10x bigger amplitude, 1000x smaller amplitude.

Statistical characterization of a signal

mean

variance = mean of the squared value, like power

standard deviation = sq root of variance = mean of squared value = RMS

median

interquartile range

min/max

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