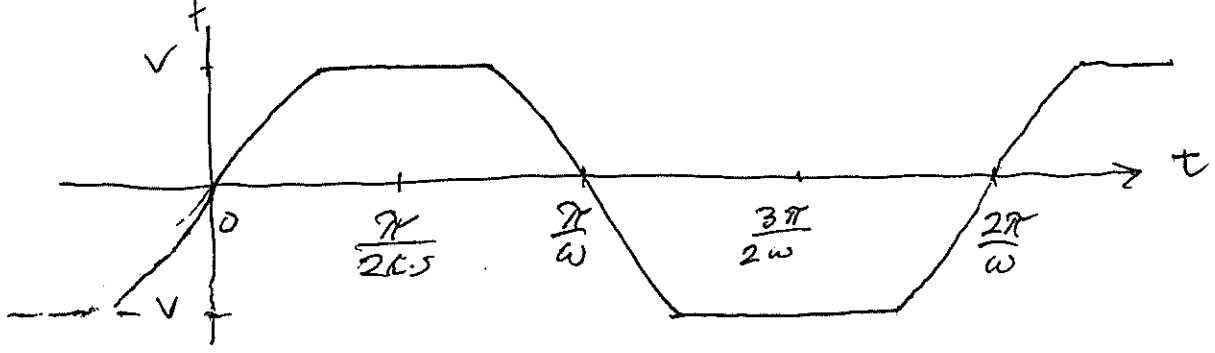
ECE 205 ASSIGNMENT 7

1. As we know, the steady-state response to a sinusoidal input is a sinusoid of the same frequency, if the system in question is represented by a stable transfer function.

This need not be the case for nonlinear systems. Consider the case of an amplifier, whose output "saturates" when it reaches the supply voltage. Its response to a sinusoid of sufficient amplitude may look like this:



- that is

$$f(t) = \begin{cases} A \sin \omega t, & \text{if } |A \sin \omega t| < V \\ V, & \text{if } A \sin \omega t \geq V \\ -V, & \text{if } A \sin \omega t \leq V \end{cases}$$

Find the Fourier series of $f(t)$, and compare it to the "unclipped" signal $A \sin \omega t$.

2. Find the Fourier series of the following functions:

a) $f(t) = 2t$, $-\frac{T}{2} \leq t < \frac{T}{2}$

& $f(t+T) = f(t)$, $\forall t$

b) $g(t) = t^2$, $-\frac{T}{2} \leq t < \frac{T}{2}$

& $g(t+T) = g(t)$, $\forall t$

Discuss the relationship of the two series.

3. Let $f(t)$ be piecewise-smooth on $[-\frac{T}{2}, \frac{T}{2}]$ and let $g(t) = f(t - t_0)$, for some t_0 and for all t. Relate the coefficients of the respective Fourier series of f and g.

4. Define

$$h(t) = \delta(t), \quad -\frac{T}{2} \le t < \frac{T}{2},$$

$$h(t+T) = h(t), \quad \forall t$$

Find the Fourier series of $h(t)$, and relate it to the results of question 2.

[Because $\delta(t)$ is not, strictly speaking, a function, we're pushing the envelope here, but try turning the formal crank anyway.]