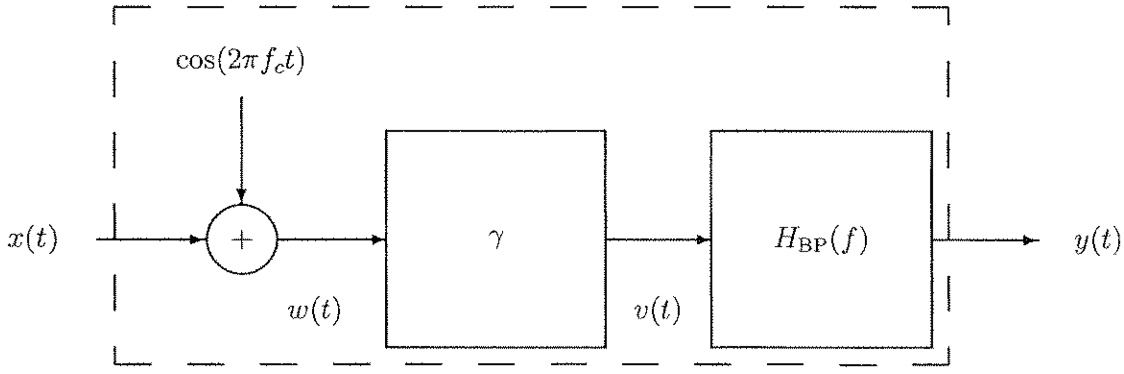
Consider the following system:



where

$$w(t) = x(t) + \cos(2\pi f_c t)$$

$$v(t) = \gamma(w(t)) \quad , \quad \gamma(w) = a_0 + a_1 w + a_2 w^2$$

$H_{\text{BP}}(f)$ as before
Require

$$X(f) = \int_{-\infty}^{\infty} x(t) e^{-j2\pi f t}\, dt = 0 \text{ for } \begin{cases} |f| \geq W \\ f = 0 \end{cases}$$

(bandlimited to $(-W, W)$ and no DC)

- Is this system time-invariant? linear?

Solution
Here I looked for one of two approaches. Either a student started trying to find the output $y(t)$ to see if the system was linear or time-invariant. When this approach was clear, I moved ahead to the next question to focus on $y(t)$ first. The other approach was to look at the system components and either argue for a property or say it looked like a property held or not. In this case the answers I sought were (1) that the system is probably not time-invariant because of the cosine, and probably not linear because it has nonlinear components (and also because of the cosine term that will get through the nonlinearity and bandpass filter). To answer this question definitively, you really need to find $y(t)$. This question usually served as a warmup for the next.