As before:
$y(t) = (c_0 + c_1 x(t))\cos(2\pi f_c t + \theta)$ is received, but θ is unknown to the receiver.

- Can the signal $x(t)$ be recovered from $\gamma(y(t))$, $\gamma(w) = a_0 + a_1 w + a_2 w^2$, and LTI filtering?

Solution

-

$$
\begin{aligned}
&\gamma(y(t)) \\
&= a_0 + a_1\left[(c_0 + c_1 x(t))\cos(2\pi f_c t + \theta)\right] \\
&\quad + a_2\left[(c_0 + c_1 x(t))\cos(2\pi f_c t + \theta)\right]^2 \\
&= \underbrace{a_0 + \frac{a_2}{2}(c_0^2 + 2c_1 x(t) + x(t)^2)}_{baseband} \\
&\quad + \underbrace{a_1\left[(c_0 + c_1 x(t))\cos(2\pi f_c t + \theta)\right]}_{passband} \\
&\quad + \underbrace{\frac{a_2}{2}(c_0 + c_1 x(t))^2\cos(4\pi f_c t + \theta)}_{highpass}
\end{aligned}
$$

The bandpass and highpass information can be knocked out by a low pass filter, and they cannot be brought down to baseband by a LTI. So only the baseband terms can be used. There the $x(t)^2$ covers the $x(t)$, so there is no way in general to recover $x(t)$ alone from this signal using only LTI filtering.