HW1：信号通过线性系统：

$x(t) = \cos t + \cos 2t$

有 $\tilde{X}(j\omega) = \pi\left[\delta(\omega+1)+\delta(\omega-1)\right] + \pi\left[\delta(\omega+2)+\delta(\omega-2)\right]$

(1)：$A(\omega)=1$，$\varphi(\omega) = -k\omega$，$k = \frac{\pi}{2}$

$\tilde{H}(j\omega) = \exp(-j\frac{\pi}{2}\omega) = \cos(-\frac{\pi}{2}\omega) - j\sin(-\frac{\pi}{2}\omega)$

$= \cos(\frac{\pi}{2}\omega) - j\sin(\frac{\pi}{2}\omega)$.

输出信号是输入信号的延时，无非线性畸变

(2)：$A(\omega)=\omega$，$\varphi(\omega) = -\frac{\pi}{2}\omega$

有 $\tilde{H}(j\omega) = \omega\cos(\frac{\pi}{2}\omega) - j\omega\sin(\frac{\pi}{2}\omega)$.

输出信号是纯虚信号，其幅值也与原信号不符

因而其存在线性畸变.

(3)：$A(\omega)=1$，$\varphi(\omega) = -k\omega = -\frac{\pi}{2}$

$\tilde{H}(j\omega) = A(\omega)\exp(j\varphi(\omega)) = \exp(j(-\frac{\pi}{2})) = -j$

同样存在非线性失真

HW2：信号通过线性系统是否会产生失真？是否可以通过级联其他系统消除？信号通过非线性系统是否会产生失真？是否可以通过级联其他系统消除？

(1)：会产生失真.

(2)：可以通过级联消除

(3)：通过非线性系统也会产生失真.

(4)：不行，非线性系统会产生新频率分量，无法通过直接级联系统消除.

HW3：

$x(t) = A\cos\omega_0 t$

$y(t) = \frac{A}{4}\cos(\omega_0 t + \varphi_1) + \frac{A^2}{8}\cos(2\omega_0 t + \varphi_2)$

记：$y_1(t) = \frac{A}{4}\cos(\omega_0 t + \varphi_1)$

$y_2(t) = \frac{A^2}{8}\cos(2\omega_0 t + \varphi_2)$

则有：$\tilde{Y}_1(j\omega) = \frac{A}{4}\pi\left[\delta(\omega+\omega_0)+\delta(\omega-\omega_0)\right]\exp(j\frac{\varphi_1}{\omega_0}\omega)$

$\tilde{X}(j\omega) = \pi A\left[\delta(\omega+\omega_0)+\delta(\omega-\omega_0)\right]$

$\Rightarrow \frac{\tilde{Y}_1(j\omega)}{\tilde{X}(j\omega)} = \frac{1}{4}\exp(j\frac{\varphi_1}{\omega_0}\omega)$.

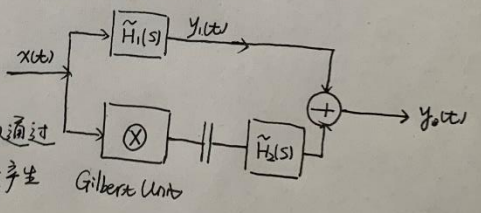
即在 ω_0 频点附近满足理想低(带)通性质

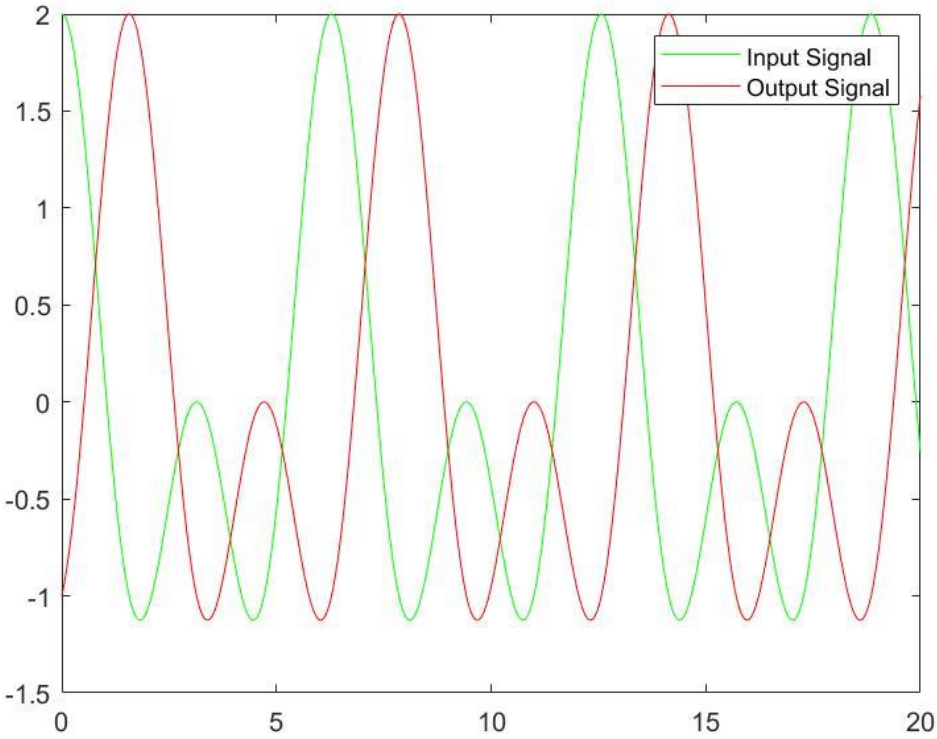
由 $x(t)\cdot x(t) = A\cos\omega_0 t \cdot A\cos\omega_0 t = \frac{A^2}{2}(1+\cos 2\omega_0 t)$

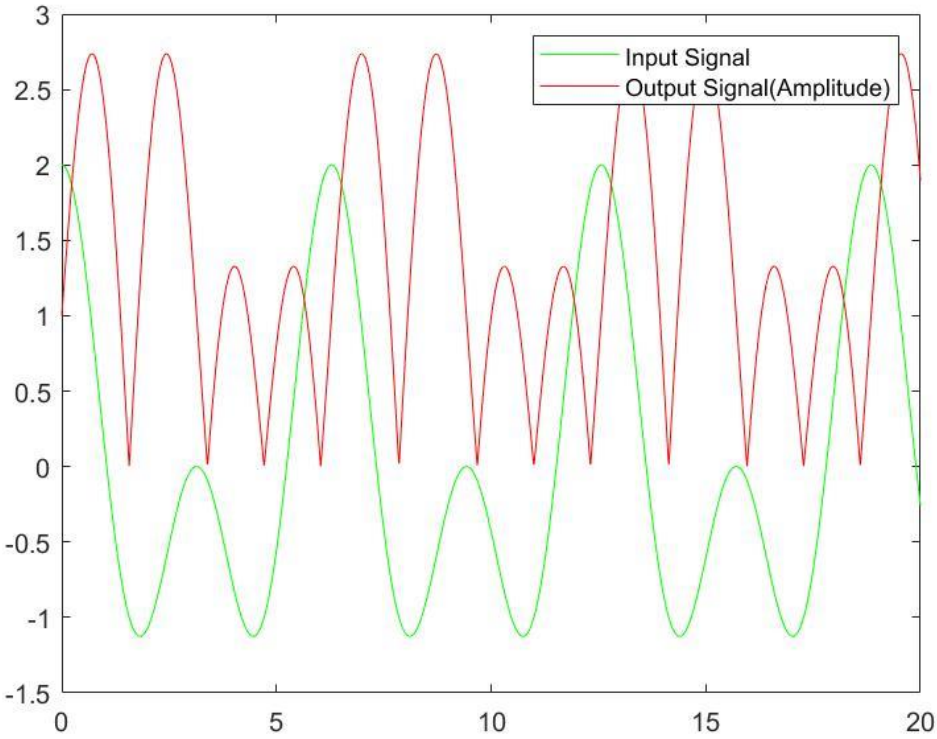
隔直电容 $\Rightarrow \frac{A^2}{2}\cos 2\omega_0 t \xrightarrow{\tilde{H}(j\omega) = \frac{1}{4}\exp(j\frac{\varphi_2}{\omega_0}\omega)} \frac{A^2}{8}\cos(2\omega_0 t + \varphi_2)$.

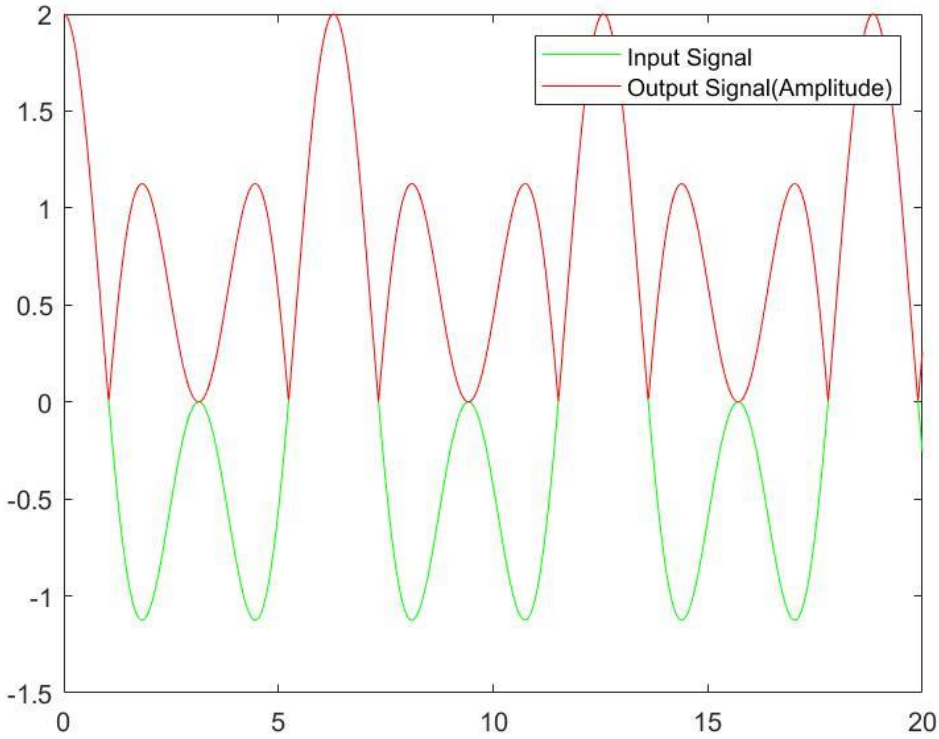
乘法器可以用一个 Gilbert 单元实现.

于是就得到其系统框图：




Input Signal
Output Signal
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
5
10
15
20


Input Signal
Output Signal(Amplitude)
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
5
10
15
20


Input Signal
Output Signal(Amplitude)
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
5
10
15
20