S(jW) — plot with axes S(jW) (vertical, 0 to 10) versus W (horizontal, -150 to 150)

s(t) — plot with axes s(t) (vertical, -1 to 1) versus t (horizontal, -5 to 5)

X(jW) — plot with axes X(jW) (vertical, 0 to 10) versus W (horizontal, -150 to 150)

x(t) — plot with axes x(t) (vertical, -15 to 10) versus t (horizontal, -5 to 5)

Y(jW) — plot with axes Y(jW) (vertical, 0 to 10) versus W (horizontal, -300 to 300)

y(t) — plot with axes y(t) (vertical, -30 to 30) versus t (horizontal, -5 to 5)

X 4.4378
Y -0.535564

Z(jW) — plot with axes Z(jW) (vertical, 0 to 5) versus W (horizontal, -1 to 1)

z(t) — plot with axes z(t) (vertical, -1 to 0.8) versus t (horizontal, -5 to 5)

X 1.2335
Y -0.578579

Questions:

1. Compare m(t) and z(t) from your result. What are the reasons that caused the signal distortion?

主因是 baseband 雜訊通過濾波器殘留，來自通道的 AWGN 混入訊號後，會在頻域拉高整個頻譜底噪並在時域中造成解調信號 x(t) 的抖動。雖然解調階段有乘上 cos(2π×100t)，嘗試搬回 baseband，但仍會混入一些雜訊到 baseband。最後的 LPF(jω) 也嘗試去掉高頻成分，但也無法完全消除 baseband 雜訊（因為雜訊是白色的，頻域成分均勻分佈）。

2. Change the noise constant 0.1 in AWGN parameter to 1. What will happen to z(t)? Explain.
Note: You have to paste the result z(t) signal for this problem.
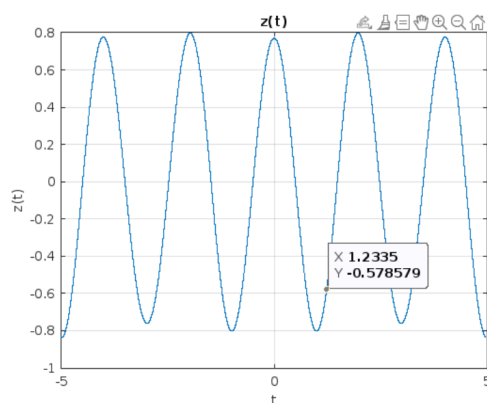
 - the noise constant 0.1 in AWGN
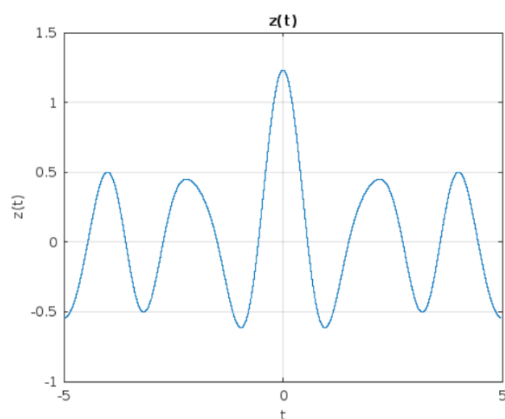
 the noise constant 1 in AWGN

z(t) 的波形還能看到主週期性結構，但抖動更嚴重且局部幅度被拉高或拉低（不對稱失真）。如果繼續增加 noise constant，可能整體都淹沒在雜訊中，看不到原始結構。

3. Assume a perfect channel with AWGN n(t) = 0, derive Y(jω) and y(t) with hand calculations.

AWGN $n(t) = 0$ $\Rightarrow$ $x(t) = s(t) = m(t) \cdot c(t) = \cos(\pi t) \cdot \cos(2\pi \cdot 100 t)$

$y(t) = x(t) \cdot 2\cos(2\pi \cdot 100 t)$

$= \cos(\pi t) \cdot (2\cos^2(2\pi \cdot 100 t))$

$= \cos(\pi t) \cdot (1 + \cos(400\pi t))$

$= \cos(\pi t) + \cos \pi t \cdot \cos(400\pi t)$

高頻項 ⇒ 通過 LPF 後, 會被濾掉

$\frac{1}{2} e^{j\pi t} + \frac{1}{2} e^{-j\pi t} + \frac{1}{4} e^{j401\pi t} + \frac{1}{4} e^{j399\pi t} + \frac{1}{4} e^{-j} \quad + \frac{1}{4} e^{-}$

$Y(j\omega) = \mathcal{F}(y(t)) = \int_{-\infty}^{\infty} \left(\frac{1}{2} e^{j\pi t} + \frac{1}{2} e^{-j\pi t} + \frac{1}{4} e^{j401\pi t} + \frac{1}{4} e^{-j401\pi t} \right) e^{-j\omega t} \, dt$

$= \pi \cdot \delta(\omega - \pi) + \pi \, \delta(\omega + \pi) + \frac{\pi}{2} \cdot \delta(\omega - 401\pi) + \frac{\pi}{2} (\omega - 399\pi)$

$+ \frac{\pi}{2} \delta(\omega + 399\pi) + \delta(\omega + 401\pi)$