Task 1

$$h[n] = \sum_{k=0}^{\infty} b_k \delta[n - kD]$$

- Let $b_k = \{\underline{1}, 0.9, 0.8, 0.7\}$, and let $D = 1000$.

☆ Digital Echo system:

$$h[n] = b_0 \delta[n-0] + b_1 \delta[n-D] + b_2 \delta[n-2D] + b_3 \delta[n-3D]$$
$$= 1\,\delta[n] + 0.9\,\delta[n-1000] + 0.8\,\delta[n-2000] + 0.7\,\delta[n-3000]$$

$$H(z) = 1 + 0.9\,z^{-1000} + 0.8\,z^{-2000} + 0.7\,z^{-3000}$$

↳ get numerator and denominator to draw pole-zero plot

$b = [1, 0.9, 0.8, 0.7]$

$a = [1]$

$$\because H(z) = \frac{Y(z)}{X(z)}$$

$$Y(z) = H(z)\,X(z)$$
$$= X(z) + 0.9\,z^{-1000} X(z) + 0.8\,z^{-2000} X(z) + 0.7\,z^{-3000} X(z)$$

$$y[n] = x[n] + 0.9\,x[n-1000] + 0.8\,x[n-2000] + 0.7\,x[n-3000]$$

☆ Equalizer system:

$$H(Z)\,G(z) = 1$$

$$\therefore G(Z) = \frac{1}{H(Z)}$$

$$\therefore G(z) = \frac{1}{1 + 0.9\,Z^{-1000} + 0.8\,Z^{-2000} + 0.7\,Z^{-3000}}$$

$\therefore$ $b = [1]$

$a = [1, 0.9, 0.8, 0.7]$

$$G(Z) = \frac{Y(Z)}{X(Z)}$$

$$\therefore Y(Z)[1 + 0.9\,Z^{-1000} + 0.8\,Z^{-2000} + 0.7\,Z^{-3000}] = X(z)$$

$$\therefore y[n] + 0.9\,y[n-1000] + 0.8\,y[n-2000] + 0.7\,y[n-3000] = X[n]$$

$$\therefore y[n] = X[n] + 0.9\,y[n-1000] + 0.8\,y[n-2000] + 0.7\,y[n-3000]$$