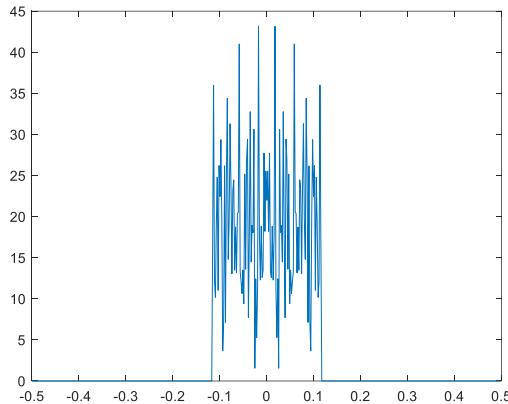


PROBLEM:

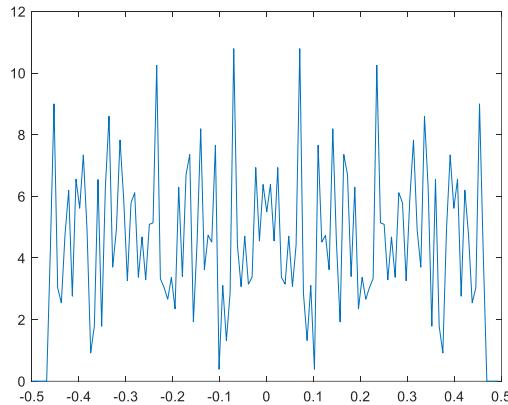
- For a given signal (S6HW.mat), try to conduct down-sampling with a largest factor without causing aliasing.
- Design an IIR filter to conduct up-sampling and interpolation recovering the original signal.
- Design a FIR filter to do the same job.

I. down-sampling with a largest factor without causing aliasing

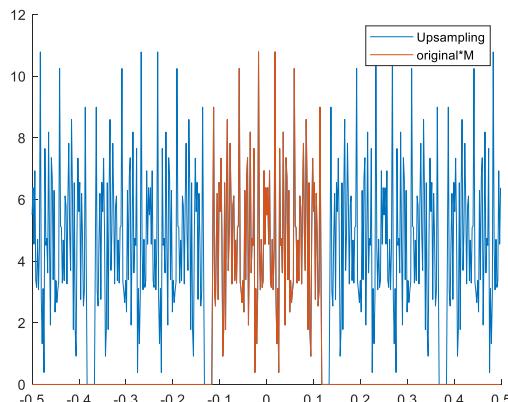
A. 從頻譜 $X[k]$ 中發現，只有 $-60 \leq k \leq 60$ 有值。



B. 取 $M = \left\lfloor \frac{N}{60} \right\rfloor$, $N = \text{length}(x)$, 做為 largest factor。down-sampling 後的頻譜如下，可以看到頻譜展開了 M 倍寬，但不超過[-0.5, 0.5]的範圍，所以不會造成 aliasing。

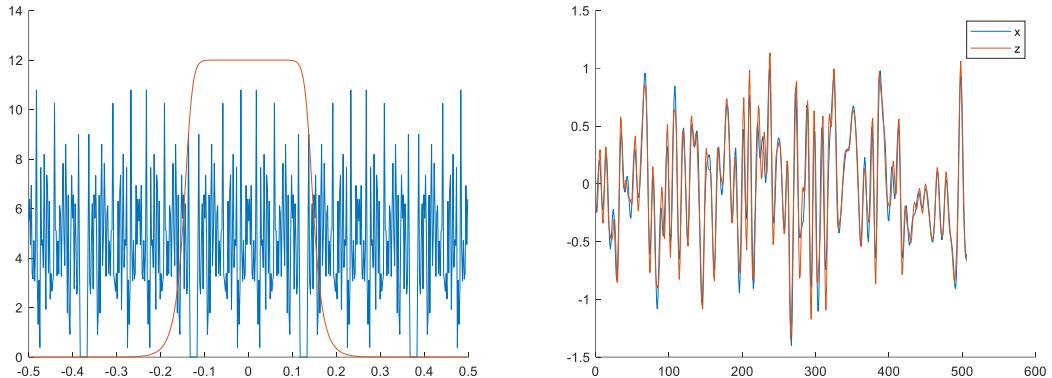


C. 做 up-sampling 復原回去和原本的頻譜 X 比對，可以看到中間部分是重和的，代表沒有失真，沒有 aliasing。



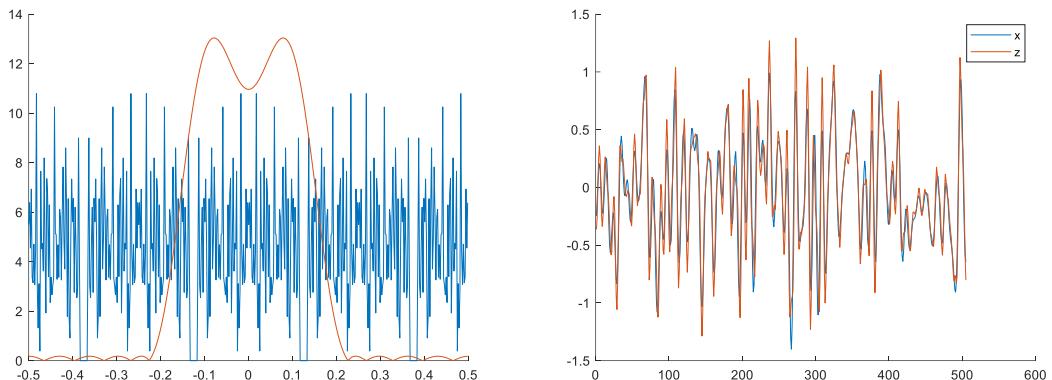
II. IIR filter

$F_{\text{pass}} = 0.12$	$A_{\text{pass}} = 1dB$
$F_{\text{stop}} = 0.22$	$A_{\text{stop}} = 40dB$
$\text{MSE(dB)} = -17.5221dB$	



III. FIR filter

$F_{\text{pass}} = 0.12$	$A_{\text{pass}} = 1dB$
$F_{\text{stop}} = 0.22$	$A_{\text{stop}} = 40dB$
$\text{MSE(dB)} = -15.6457dB$	



A. 同樣的參數設定下，IIR 濾的結果比 FIR 好。

B. $\Delta f = F_{\text{stop}} - F_{\text{pass}}$ ，如果 Δf 太窄，會需要很高階數的濾波器才能達到，但這個延遲將明顯增加，濾波後的波形可能變形，所以最後選擇 [0.12, 0.22] 作為 LPF 從通過降到阻擋的頻率範圍。