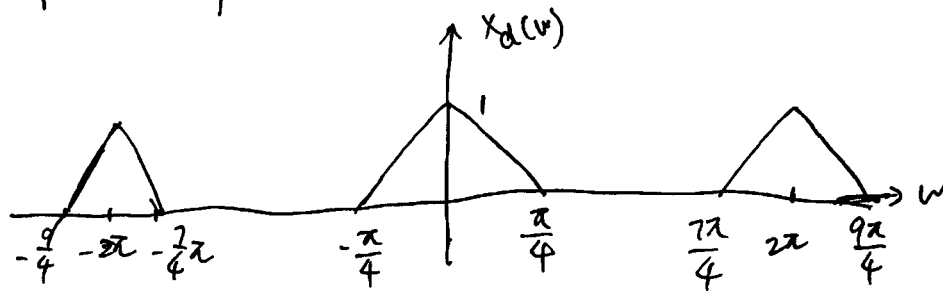
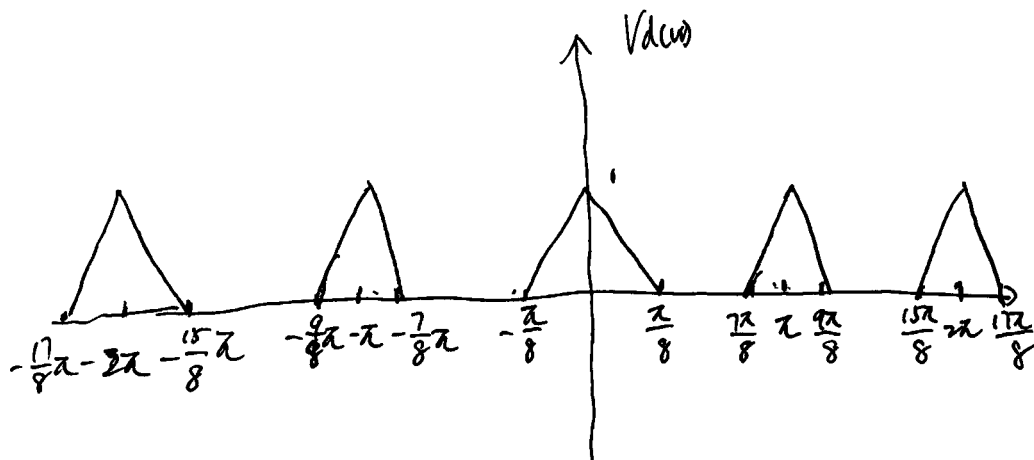


ECE 310 HW11 Soln

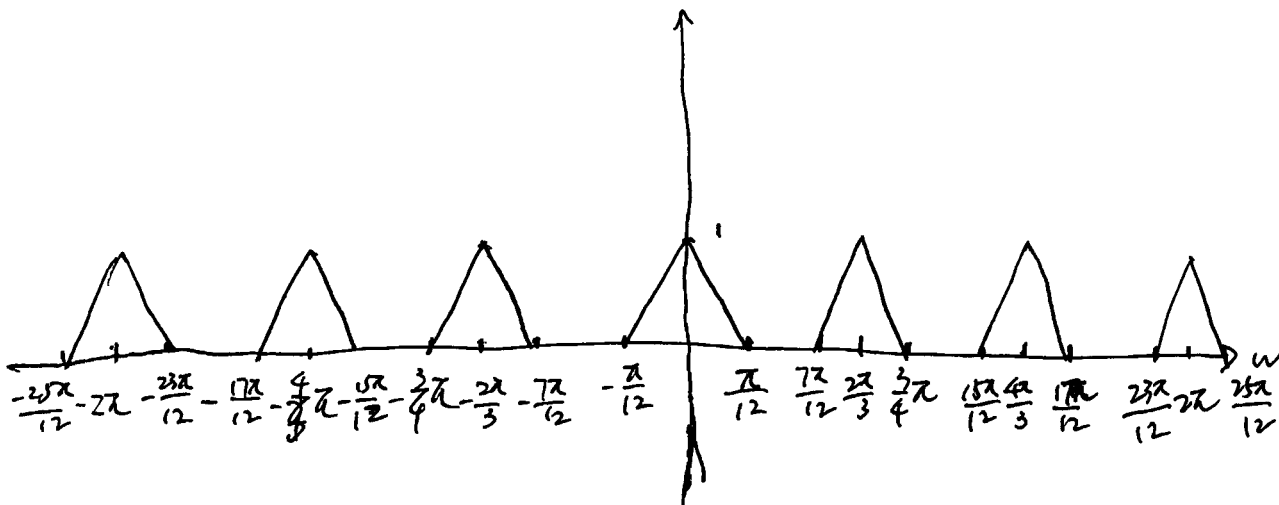
1. The spectrum of $X_d(\omega)$ is shown below:



a) $L=2$

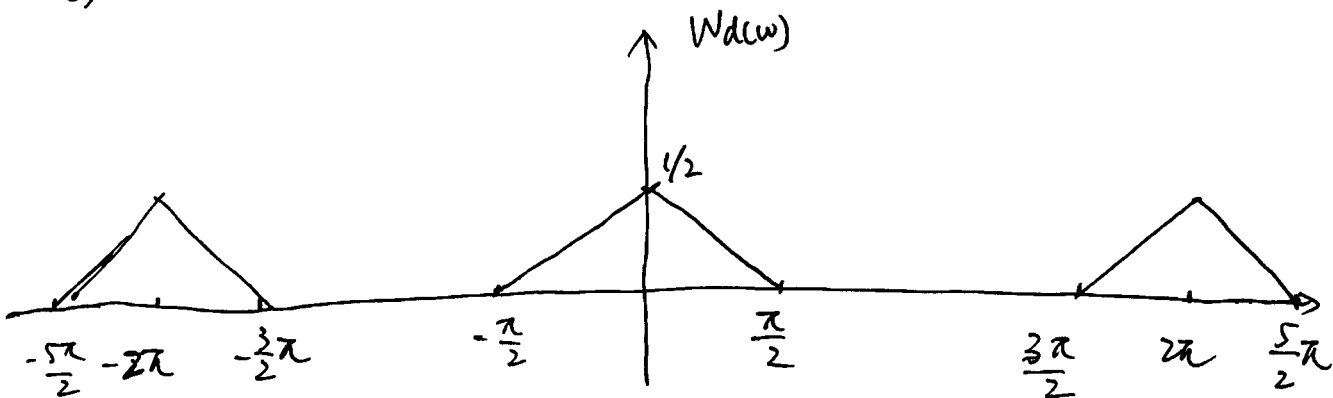


b) $L=3$



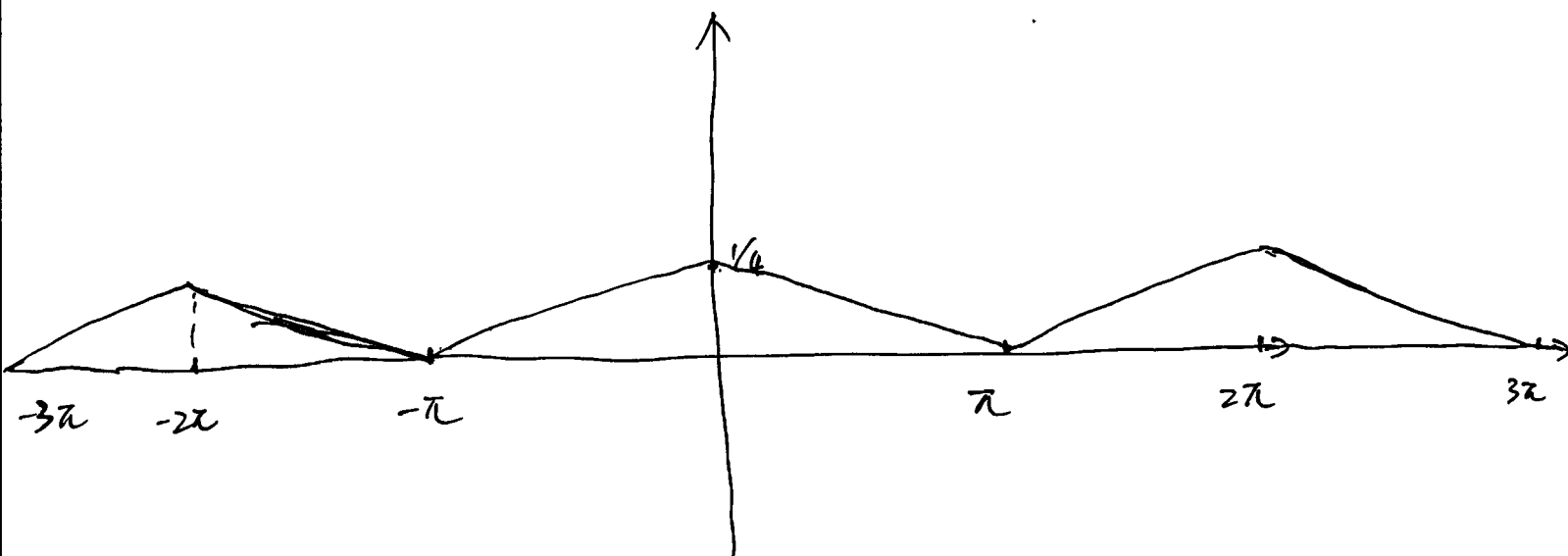
c)

$$D=2$$



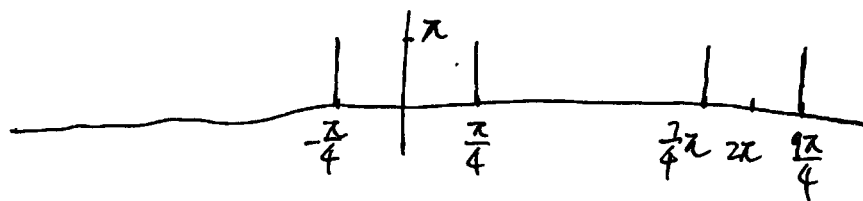
d)

$$D=4$$

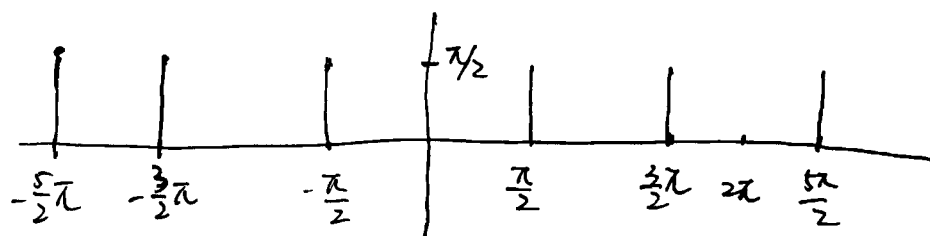


2. a) $x[n] = \cos\left(\frac{\pi}{4}n\right)$

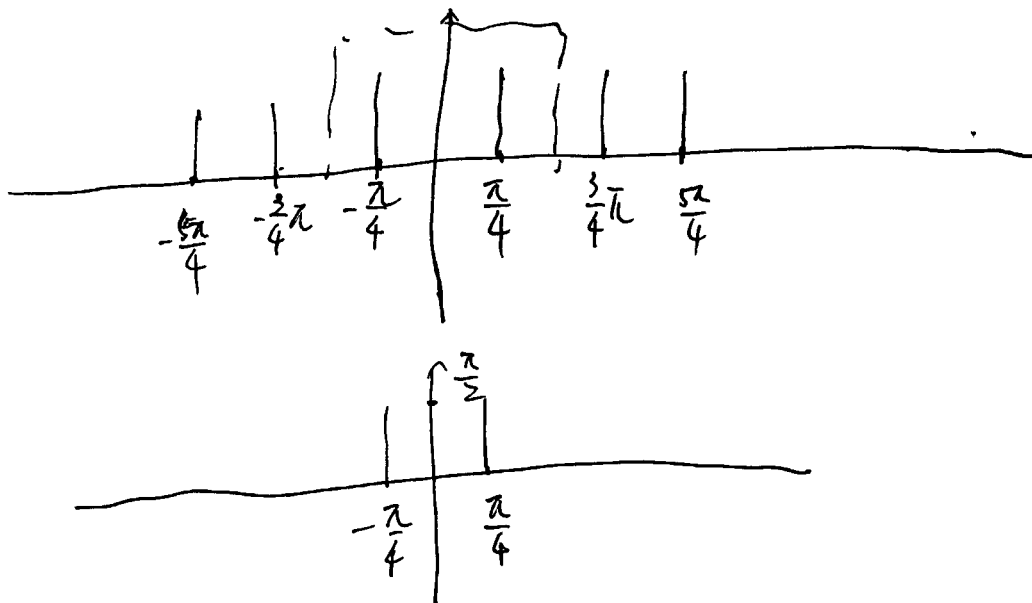
The spectrum of $X_d(\omega)$ is shown below,



Downsampled by 2:

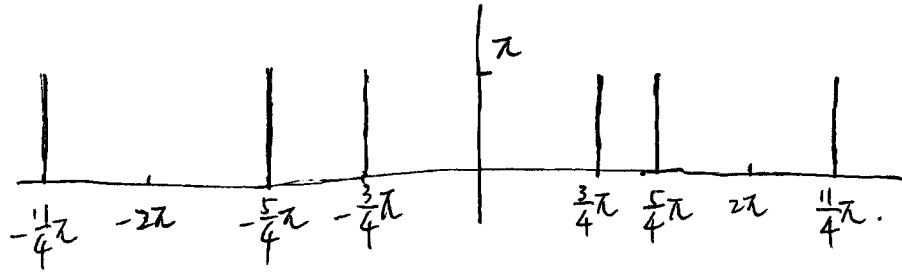


upsampled by 2 : and low pass filtering

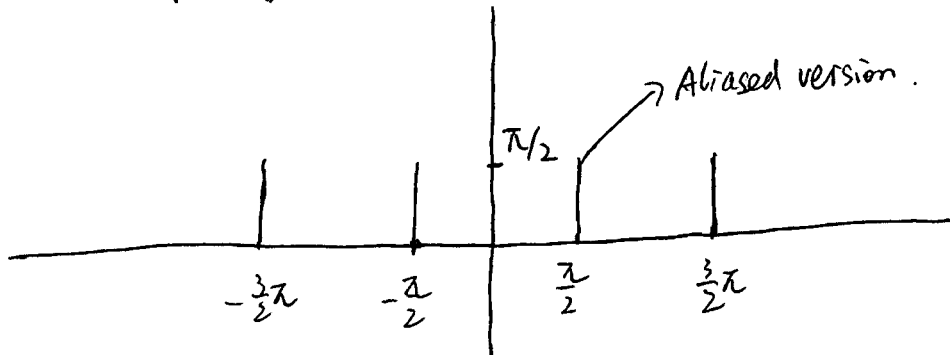


$$y[n] = \frac{1}{2} \cos \frac{\pi}{4} n$$

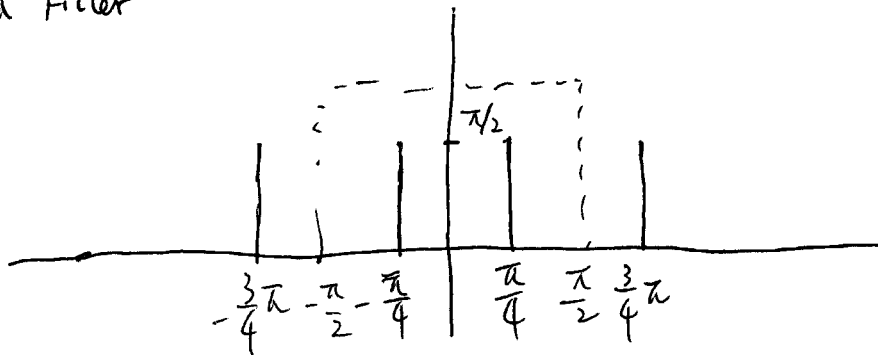
b) $x[n] = \cos \frac{3\pi}{4}n$



Downsampled by 2



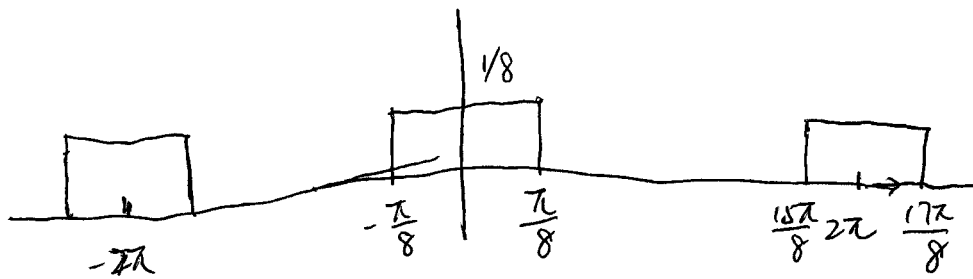
Upsampled Filter



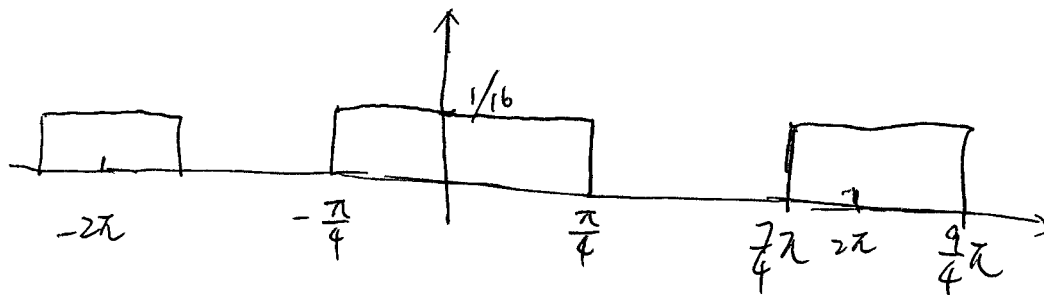
We got aliased version

$$y[n] = \frac{1}{2} \cos\left(\frac{\pi}{4}n\right)$$

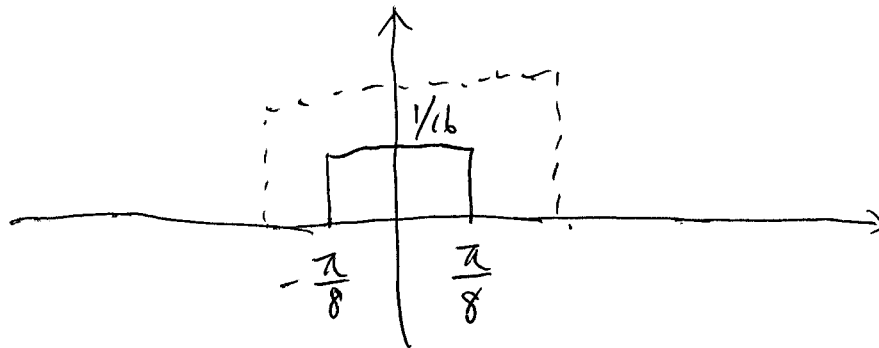
$$c) X[n] = \frac{\sin(\frac{\pi n}{8})}{\pi n}$$



down-sampled by 2,



upsampled by 2 & filter.



$$y[n] = \frac{1}{2} \frac{\sin(\frac{\pi n}{8})}{\pi n}$$

3. a) Transition band = $f_s - 2B = 44.1 - 2 \times 20 = 4.1 \text{ kHz}$

b) Transition band = $Lf_s - 2B = 2 \times 44.1 - 2 \times 20 = 48.2 \text{ kHz}$

c) Transition band = $Lf_s - 2B = 4 \times 44.1 - 2 \times 20 = 136.4 \text{ kHz}$