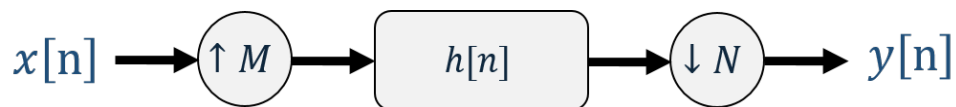
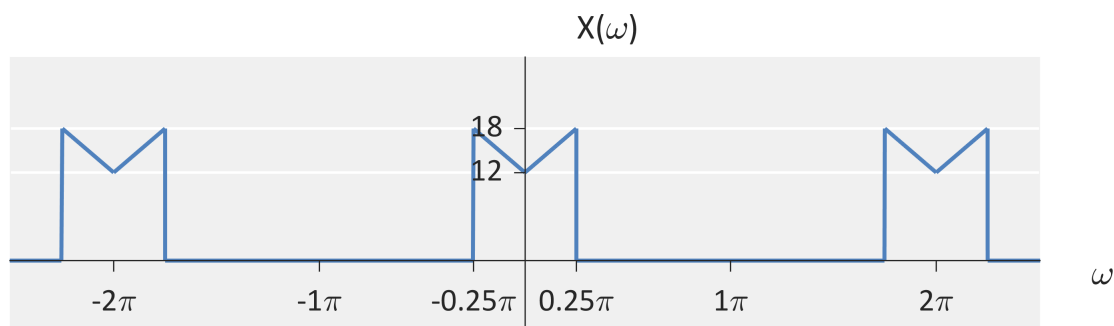
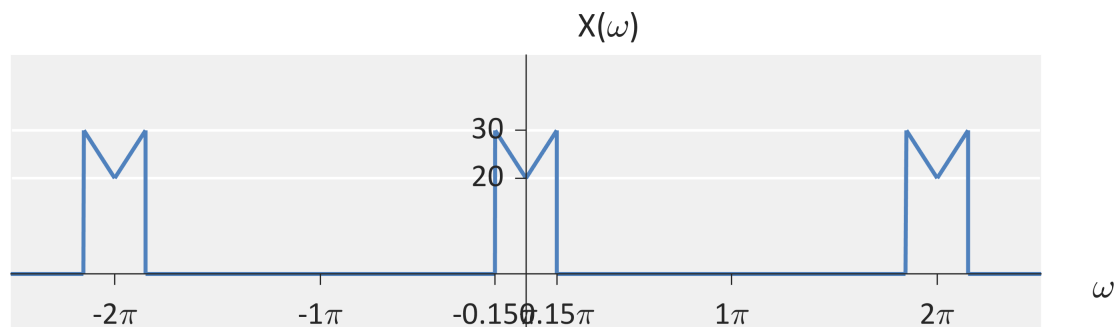


Question #1: Consider the discrete-time Fourier transform of $x[n]$ (i.e., $X(\omega)$) and the upsampling/downsampling system below. Assume $h[n]$ is an ideal decimation / interpolation filter for the given M and N .



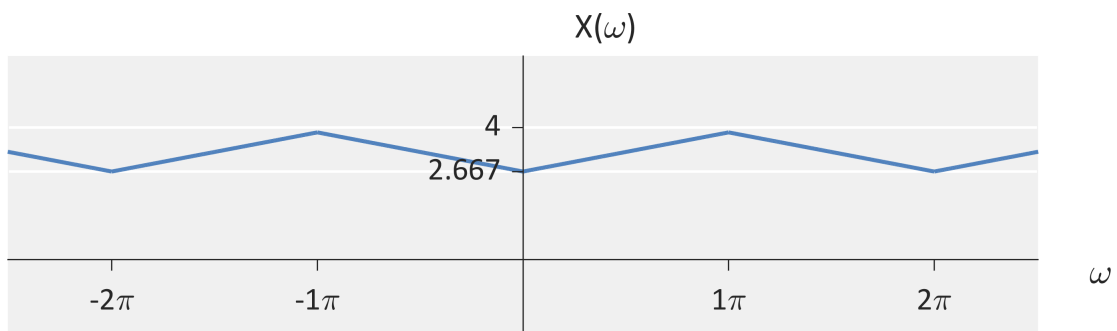
(a) Sketch DTFT of $y[n]$ (i.e., $Y(\omega)$) for $M = 5$, $N = 3$

Solution:



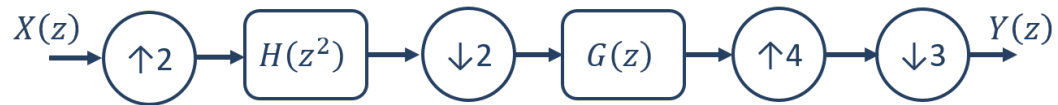
(b) Sketch DTFT of $y[n]$ (i.e., $Y(\omega)$) for $M = 2$, $N = 9$

Solution:



Question #2: One of the useful aspects of Noble properties is that they can help simplify complex expressions with downsampling and upsampling.

- (a) Use the Noble properties for upsampling and downsampling to simplify the following block diagram. Represent the results as a block diagram. It should only have one downsampling operation, one upsampling operation, and one filter operation.



Solution: Two possible solutions are shown below.

