Signal Processing Homework #2

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1. The following information is known about an LTI system:

   (i) The system is causal.

   (ii) When the input is

   $$x[n] = -\frac{1}{3}\left(\frac{1}{2}\right)^n u[n] - \frac{4}{3}2^n u[-n-1],$$

   then the z-transform of the output is

   $$Y(z) = \frac{1 - z^{-2}}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - 2z^{-1}\right)}.$$

   a. Find the z-transform of $x[n]$.

   b. What are the possible choices for the ROC of $Y(z)$?

   c. What are the possible choices for a linear constant-coefficient difference equation used to describe the system?

   d. What are the possible choices for the impulse response of the system?

2. Consider the moving average filter

   $$h[n] = \frac{1}{M+1}\sum_{k=0}^{M}\delta[n-k].$$

   What is the group delay of the filter in terms of samples with respect to M? If the sampling period is T_s, what is the group delay in terms of seconds?

3. The sampling period is 600 Hz. Design a length-$(2N+1)$ band-pass filter such that $f_l = 100$ Hz and $f_h = 150$ Hz. Calculate the coefficients from the inverse DTFT of the ideal band-pass filter. What are the values of $h[-1], h[0], h[1]$?

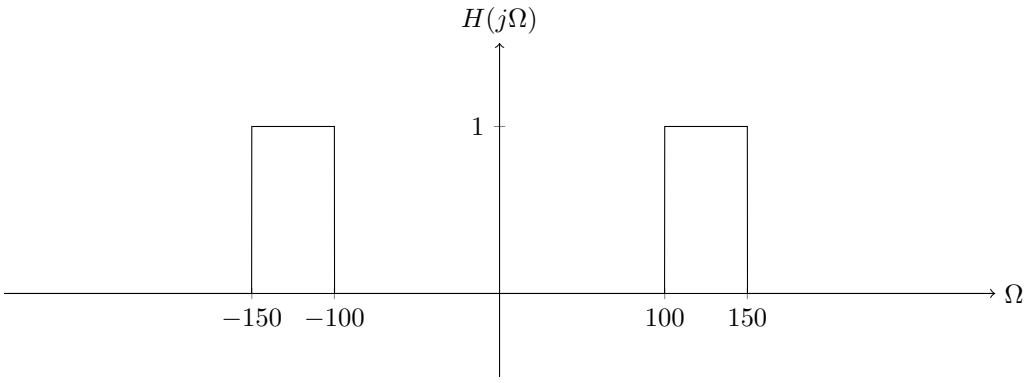

Figure 1: Ideal band-pass filter frequency response

4. The impulse response of an LTI system is $h[n]$. What is the output of the input

   $$x[n] = \delta[n] + 2\delta[n-1] + 3\delta[n-2]$$

   in terms of $h[n]$?