EE3731C Tutorial - Classical Signal 2

Department of Electrical and Computer Engineering

1. An LTI system has impulse response $h[n] = 5(-1/2)^n u[n]$. Use the DTFT to find the output of this system when the input is $x[n] = (1/3)^n u[n]$.
   $\left[\text{Hint: } \frac{1}{(1-ae^{-j\omega})(1-be^{-j\omega})} = \frac{a/(a-b)}{1-ae^{-j\omega}} - \frac{b/(a-b)}{1-be^{-j\omega}}\right]$

2. Let $h[n] = \frac{1}{M_1+M_2+1}\sum_{k=-M_1}^{M_2} \delta[n-k]$, i.e., moving average filter we discussed in class. Show that $|H(e^{j\omega})| = \left|\frac{1}{M_1+M_2+1}\frac{\sin\left(\omega(M_1+M_2+1)/2\right)}{\sin(\omega/2)}\right|$ and $\sphericalangle H(e^{j\omega}) = -\omega(M_2-M_1)/2 + \{0, \pi\}$

3. For each of the following impulse responses of LTI systems, indicate whether the system is causal:
   (a) $h[n] = (1/2)^n u[n-1]$
   (b) $h[n] = (1/2)^{|n|}$
   (c) $h[n] = u[n+2] - u[n-2]$

4. For each of the following impulse responses of LTI systems, indicate whether the system is stable:
   (a) $h[n] = 3^n u[-n-1]$
   (b) $h[n] = \sin(\pi n/3)u[n]$
   (c) $h[n] = (3/4)^{|n|}\cos(\pi n/4 + \pi/4)$

5. Show that $h[n] = \begin{cases} -\sqrt{2}/2, & n = 0 \\ \sqrt{2}/2, & n = 1 \\ 0, & \text{otherwise} \end{cases}$ is a highpass filter by computing its DTFT.