**Problem #1**

We have the following simple communications channel, where \( H_c(f) \) is shown below. We are going to use a simple two-tone multitone system to maximize capacity.

\[
\text{AWGN-}N_0/ 2 \text{ watts/Hz}
\]

The value of \( P/N_0 W = A \).

The value of \( L \) is between 0 and 1, i.e, \( 0 \leq L \leq 1 \).
a) We would like to maximize the capacity of this channel, by using the water–pouring concept. We will transmit \((kP)\) watts in the lower subchannel and \((1-k) P\) watts in the upper channel, where

\[
\frac{1}{2} \leq k \leq 1
\]

b) What is the capacity of this system if we transmit all the \(P\) watts \((k=1)\) in the lower sub-channel (for which \(\left| H_c(f) \right|^2 = 1\)).

c) Now we want to use water-pouring to maximize the capacity. First, draw the curve of \(N_0/2/\left| H_c(f) \right|^2\).

d) At which value of \(L\), will water pouring across both channels start to increase the capacity (i.e., for which value of \(L\) will \(k < 1\)).

e) Find the channel capacity of the channel if \(L=0\) and if \(L=1\).

f) Suppose \(P/N_0W = 30\) dB, and \(W\) equals 30 kHz, repeat parts (a-f),