Modern Digital Modulation Techniques ELEN E6909 Columbia University Spring Semester 2008

> PROBLEM SET # 9 Due Date: 29 April 2008

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.



The value of $P/N_0W = A$. The value of L is between 0 and 1, i.e, $0 \le L \le 1$. a) We would like to <u>maximize the capacity of this channel</u>, 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

 $1/2 \le k \le 1$

- b) What is the capacity of this system if we transmit all the P watts (k=1) in the lower sub-channel (for which $|H_c(f)|^2=1$).
- c) Now we want to use water-pouring to maximize the capacity. First, draw the curve of $N_0/2/|H_c(f)|^2$.
- 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/N₀W = 30 dB, and W equals 30 kHz, repeat parts (a-f),