

## COM 5120 Communication Theory

### Homework #5

Due: 12/30/2021

1. (20%) A voice-band telephone channel passes the frequencies in the band from 500 to 3500Hz. We want to design a modem that transmits at a symbol rate of 2000 symbols/s, with the objective of achieving 8000 bits/s. Select **an appropriate QAM signal constellation, carrier frequency**, and the **roll-off factor of a pulse** with a raised cosine spectrum that utilizes the entire frequency band. Also **sketch the spectrum** of the transmitted signal pulse.
2. (20%) A binary sequence **1001011001** is the input to a precoder with Symbol-by-symbol detection. Construct a table as below showing the precoded sequence, the transmitted amplitude levels, the received signal levels, and the decoded sequence for the following cases:
  - (a) (10%) A **duo-binary** signal ( $P_{-1} = 0$ )
  - (b) (10%) A **modified duo-binary** signal ( $P_{-1} = P_{-2} = 0$ )

Data sequence $D_n$												
Precoded sequence $P_n$												
Transmitted sequence $I_n$												
Received sequence $B_n$												
Decoded sequence $D_n$												

3. (20%) A voice-band telephone line channel has an ideal frequency response over the band of  $0\text{Hz} < f < 1200\text{Hz}$ .
  - (a) (10%) Is it possible to transmit at  $R = 2,500$  symbols/s without ISI problem? Why?
  - (b) (10%) If we transmit at  $R = 800$  symbols/s and a square-root raised cosine pulse is used for the transmitter pulse, what is the appropriate roll-off factor?
4. (20%) Consider transmission with controlled ISI using a **duo-binary signal** defined as

$$x(nT) = \begin{cases} 1, & \text{if } n = 0, 1 \\ 0, & \text{otherwise} \end{cases}$$

where the sampling period  $T = 1/(2W)$ , and  $W$  is the channel bandwidth. Please **find** and **plot** the frequency spectrum of transmission signal.

5. (20%) Consider transmission with controlled ISI using a **modified duo-binary** signal defined as

$$x(nT) = \begin{cases} +1, & \text{if } n = -1 \\ -1, & \text{if } n = +1 \\ 0, & \text{otherwise} \end{cases}$$

where the sampling period  $T=1/(2W)$ , and  $W$  is the channel bandwidth. Please **find** and **plot** the frequency spectrum of transmission signal.