

University of Pittsburgh, ECE 1150

ASSIGNMENT 4

Show all steps in answering the following questions. Make sure to put units of measurements (if applicable) in your answers.

QUESTION 1:

A signal $S(t) = \cos(32\pi t)$ is sent using a digital communication system. Answer the following questions:

- a) The signal is first sampled. What is the minimum sampling rate required to avoid aliasing?
- b) If the signal is then quantized from -1 to 1 using uniform quantizer of 8 quantization levels. Find the quantization levels.
- c) Using the quantizer in (b), what is the maximum quantization error for any given sample?
- d) With the same quantizer, how many bits are needed to represent each quantization level? Clearly write one possible way to encode all quantization levels. (i.e., assign each level to a code)
- e) A sample from (a) is equal to 0.6. Based on your answers above, what is the code that represent this sample.
- f) Assume Manchester encoding, roughly sketch the output signal corresponding to the sample in (e).

QUESTION 2:

Assume modulated symbols transmitted over a communication channel. A communication link supports a maximum rate of 2 G symbols/sec. Assume that 5 channels (channel 1 to channel 5) are multiplexed over that link using TDM.

- a) What is the maximum symbol rate of channel 1 (average over time)?
 - b) If channel 1 uses QPSK modulation, what is the bit rate sent over that channel?
 - c) If channel 2 uses 64-QAM. What is the bit rate over that channel?
- In the same way,

QUESTION 3:

Assume a voice channel with 2 kHz bandwidth. We need to multiplex 5 voice channels using FDM. In doing so, guard bands of 200 Hz are needed between two neighboring channels. Calculate the total bandwidth required.

QUESTION 4:

How many frequencies are used in an FDD, 64-QAM modem? Justify your answer.