

# CS 4390: HW 3

Written by Zach Leach, NetID: zcl190002

Draft February 20, 2024

## 1 Data Rate Problem 4

*It is desired to send a sequence of computer screen images over optical fiber. The screen is  $3840 \times 2160$  pixels, each pixel being 24 bits. There are 60 screen images per second. What data rate is needed?* 5

$$\text{Data Rate} = \frac{\text{Number of bits}}{\text{Bits per second}} \quad 6$$

There are  $24 \text{ bits} \cdot (3840 \times 2160) = 199,065,600$  bits per image. Transmitting 60 images per second gives a data rate of data rate is  $60 \cdot 199,065,600 = \underline{1.194 \cdot 10^{10}}$  bits per second. 7

## 2 FDM Multiplexing Problem

*Ten signals, each requiring 4000 Hz, are multiplexed onto a single channel using FDM. What is the minimum bandwidth required for the multiplexed channel? Assume that the guard bands are 400 Hz wide.*

$$\text{Bandwidth} = [\# \text{ of channels} \cdot \text{channel bandwidth}] + [(\# \text{ of channels} - 1) \cdot \text{guard band width}]$$

The minimum bandwidth required is  $[10 \cdot 4000\text{Hz}] + [(9) \cdot 400\text{Hz}] = \underline{43,600 \text{ Hz}}$ .

## 3 Analog Sampling Data Rate Problem

*A 3-kHz (analog) signal is sampled every 1 msec. What is the (minimum) data rate of a digital channel required to carry this signal? Assume that the quantization uses 256 levels.*

$$\text{Minimum Data Rate} = 2 \times \text{Bandwidth} \times \log_2(\# \text{ of Q-Levels})$$

The minimum data rate is  $2 \times (3 \cdot 10^3) \times \log_2(256) = \underline{48,000 \text{ bits per second}}$ .