

ITS323 – Data Transmission Notes

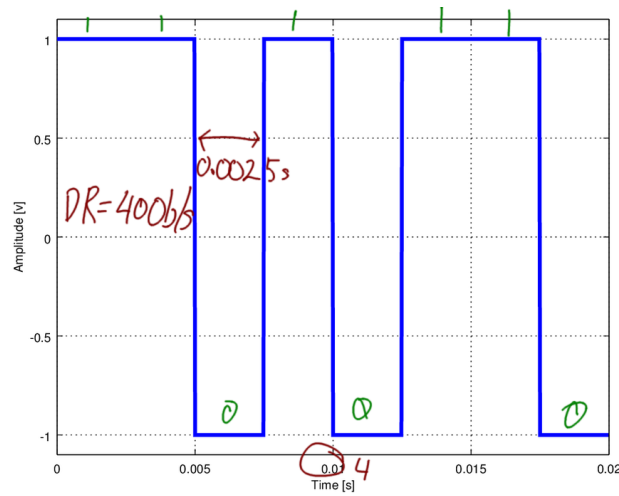


Figure 1: Example of digital data as digital signal 1; Lecture 02

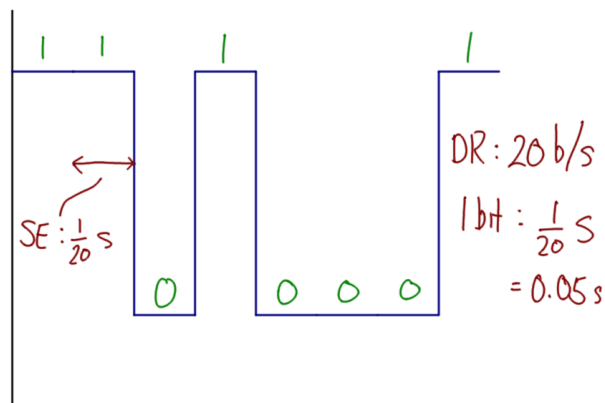


Figure 2: Example of digital data as digital signal 2; Lecture 02

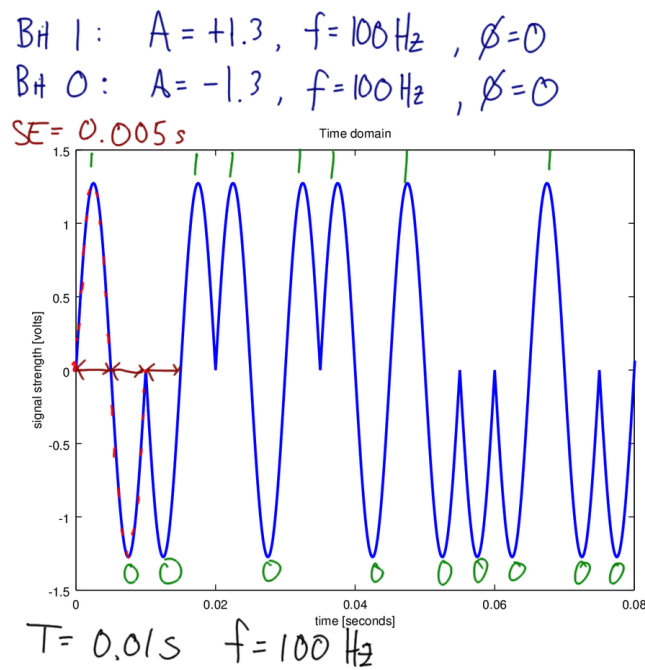


Figure 3: Example of digital data as analog signal 1; Lecture 02

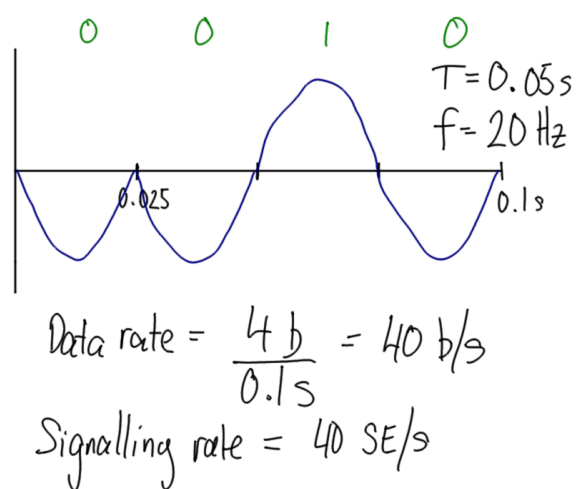


Figure 4: Digital Data as Analog Signal 2a; Lecture 03

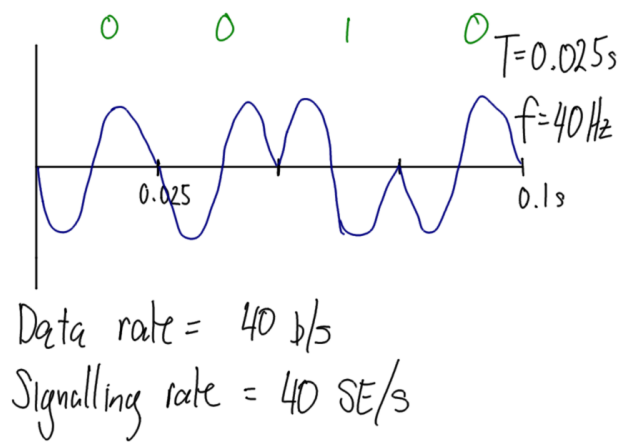


Figure 5: Digital Data as Analog Signal 2b; Lecture 03

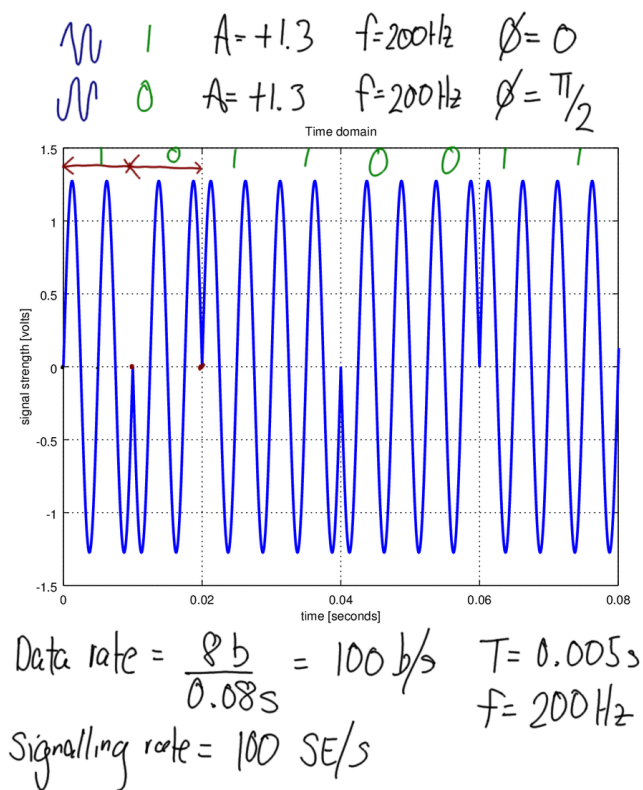


Figure 6: Digital Data as Analog Signal 3; Lecture 03

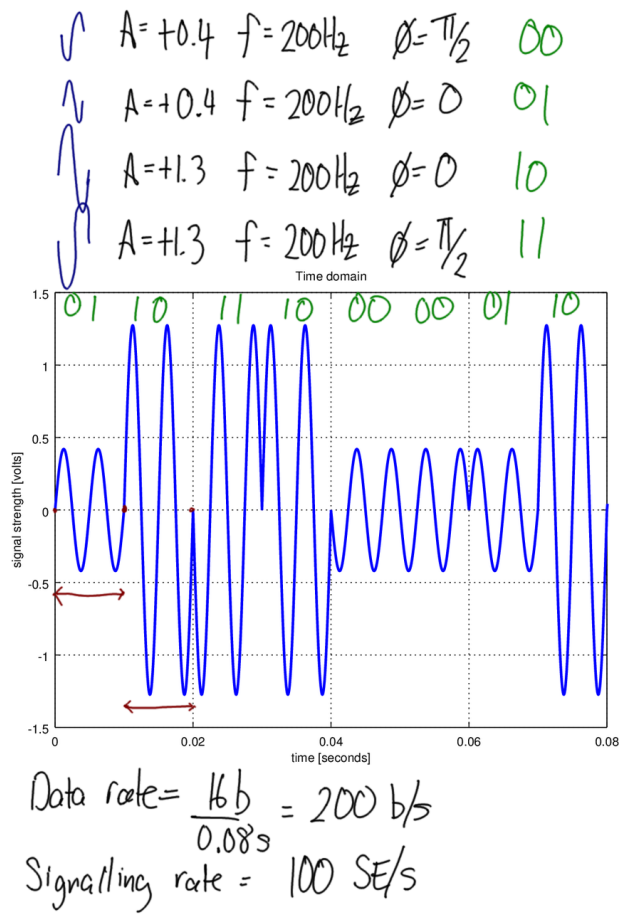


Figure 7: Digital Data as Analog Signal 4; Lecture 03

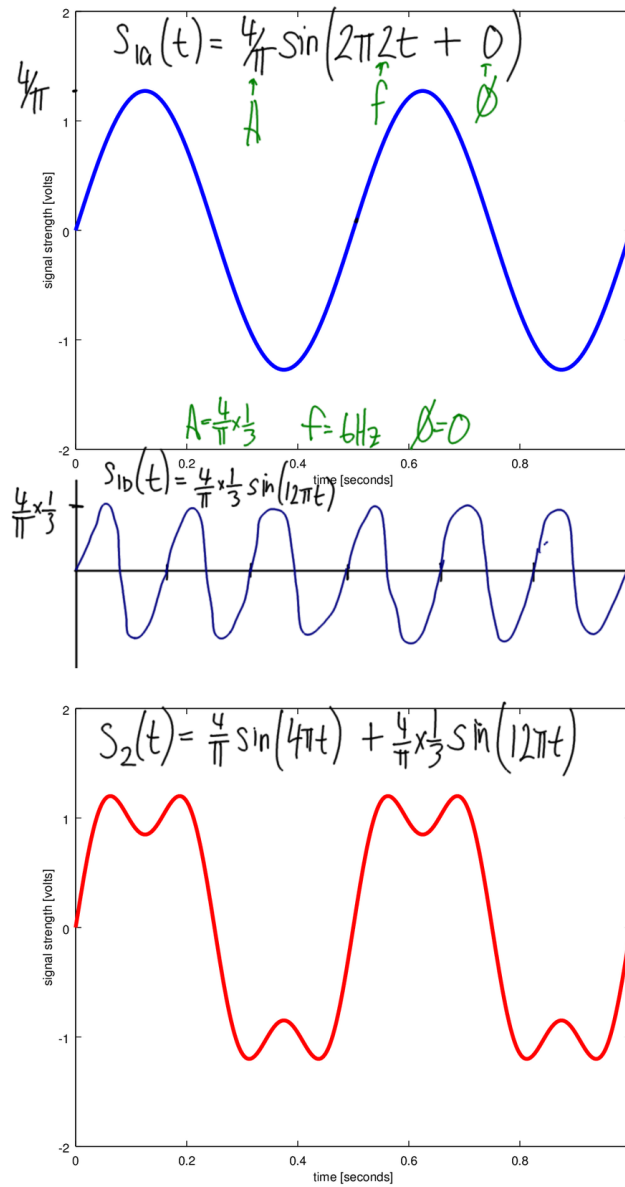


Figure 8: Signal 2 composed of Sine 1a and 1b; Lecture 03

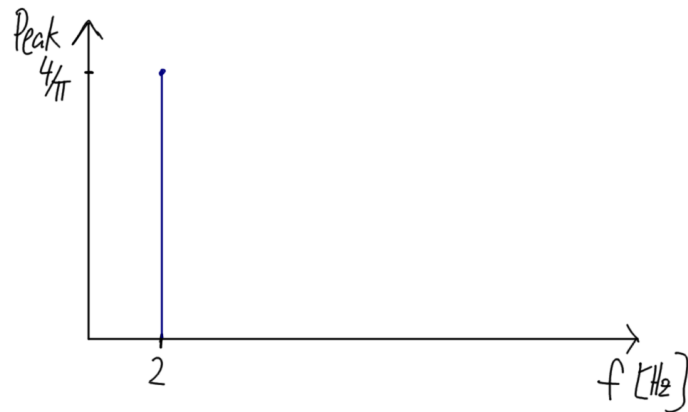
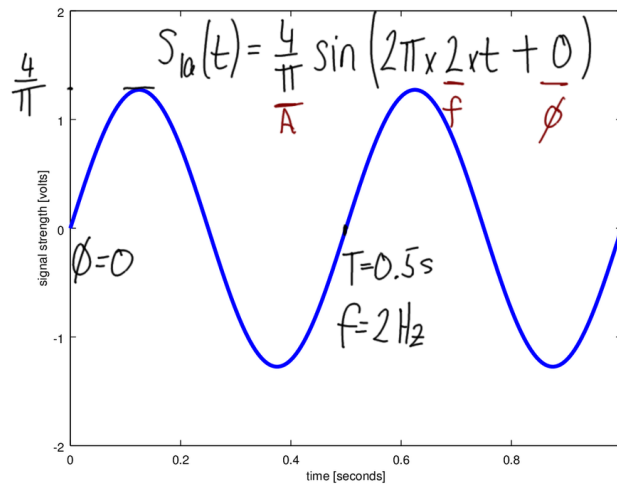


Figure 9: Signal 1a in Time and Frequency Domain; Lecture 04

$$S_2(t) = \frac{4}{\pi} \sin(4\pi t) + \frac{4}{\pi} \times \frac{1}{3} \sin(12\pi t)$$

$A = \frac{4}{\pi} \quad f = 2 \qquad A = \frac{4}{\pi} \times \frac{1}{3} \quad f = 6$

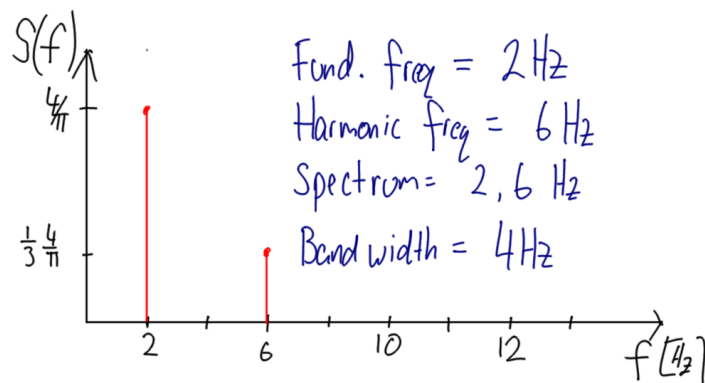
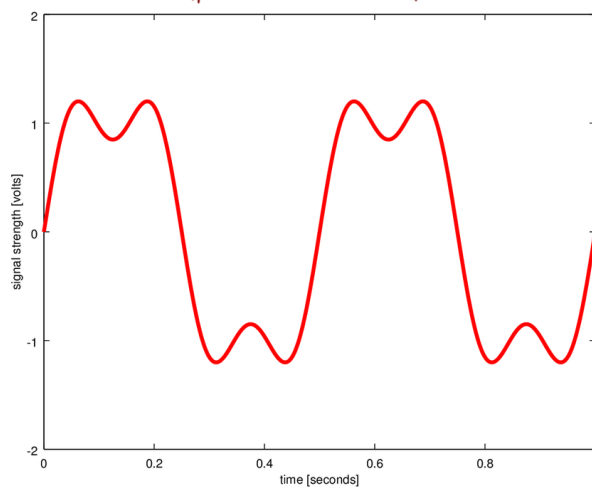


Figure 10: Signal 2 in Time and Frequency Domain; Lecture 04

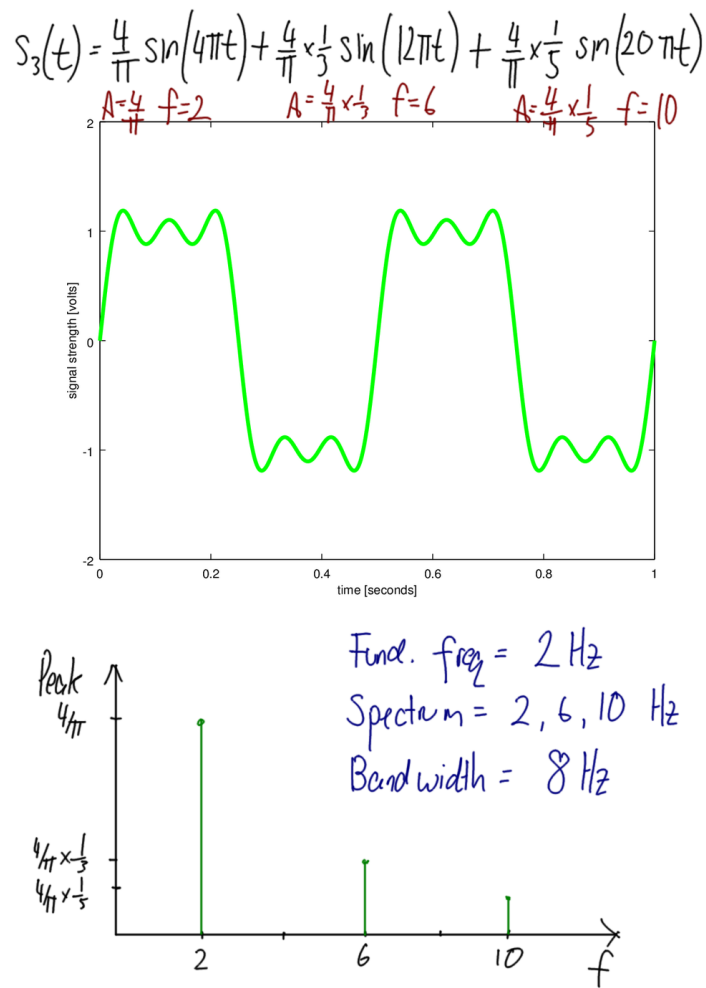


Figure 11: Signal 3 in Time and Frequency Domain; Lecture 04

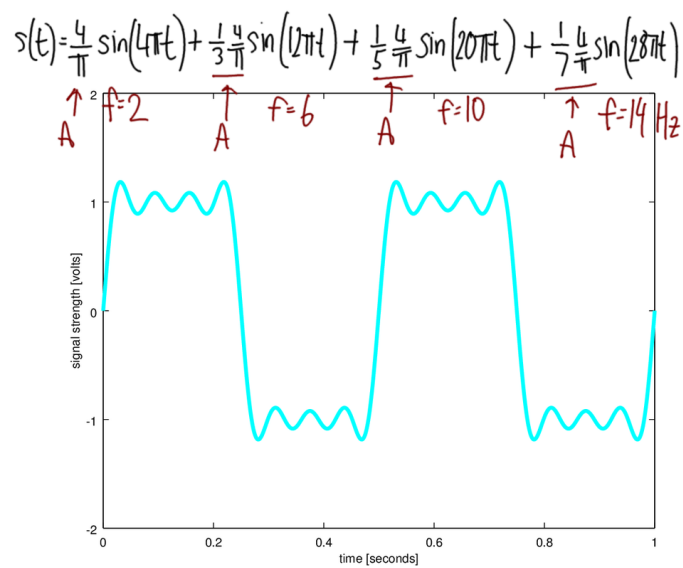


Figure 12: Signal 4 in Time Domain; Lecture 04

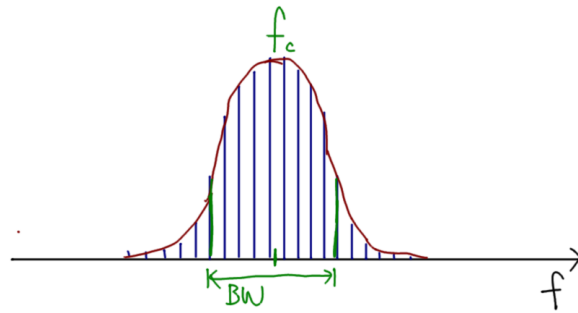


Figure 13: Example of Practical Signal Bandwidth; Lecture 04

$BW = 2000\text{Hz}$, $f = 1000\text{Hz}$, $T = 1\text{ms}$, $DR = 2000\text{ b/s}$
 $BW = 4000\text{Hz}$, $f = 2000\text{Hz}$, $T = 0.5\text{ms}$, $DR = 4000\text{ b/s}$
 $BW = 8000\text{Hz}$, $f = 4000\text{Hz}$, $T = 0.25\text{ms}$, $DR = 8000\text{ b/s}$

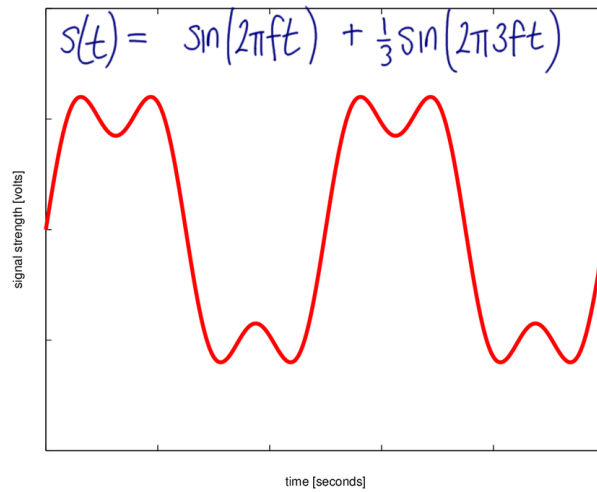


Figure 14: Tradeoff between Bandwidth and Data Rate; Lecture 05

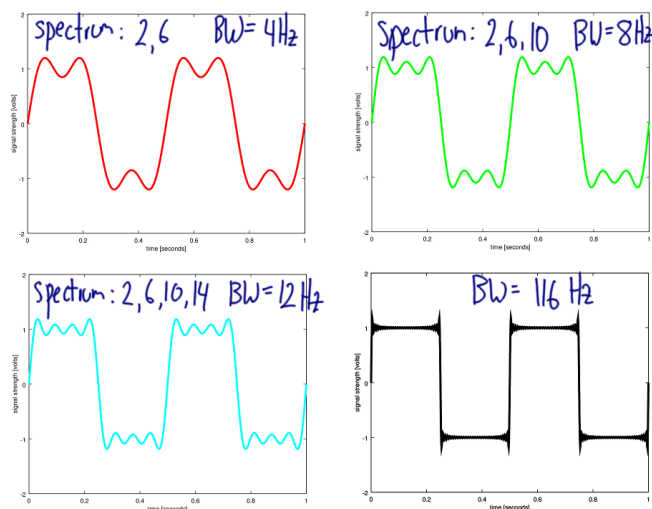


Figure 15: Tradeoff between Bandwidth and Errors; Lecture 05

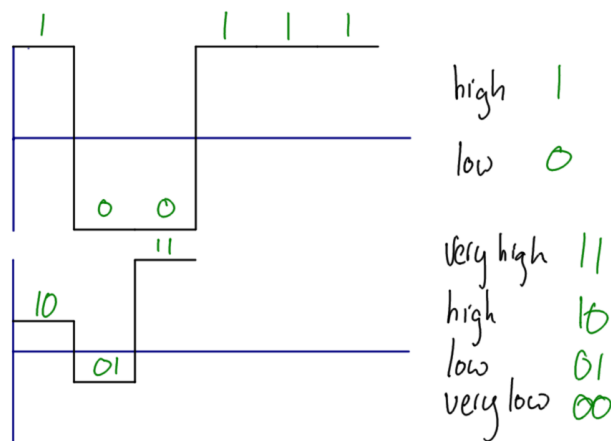


Figure 16: Tradeoff between Levels and Errors; Lecture 05

$$\begin{array}{c}
 A \text{ --- } B = 3100 \text{ Hz} \text{ --- } B \\
 \text{modem} \qquad \qquad \qquad \text{ISP}
 \end{array}$$

$$\begin{aligned}
 M=2 : C &= 2B \log_2(m) \\
 &= 2 \times 3100 \times \log_2(2) \\
 &= 6200 \text{ b/s}
 \end{aligned}$$

$$\begin{aligned}
 C=56 \text{ kb/s} : C &= 2B \log_2(m) \\
 56000 &= 2 \times 3100 \times \log_2(m) \\
 \log_2(m) &= 9 \\
 m &= 512
 \end{aligned}$$

$$\begin{aligned}
 M=1024 : C &= 6200 \times \log_2(1024) \\
 &= 62 \text{ kb/s}
 \end{aligned}$$

Figure 17: Nyquist Capacity Example; Lecture 05

$$\begin{array}{c}
 X \xrightarrow[\text{SNR} = 251]{B = 1\text{MHz}} Y \\
 \\
 \text{Shannon:} \\
 C = B \log_2(1 + \text{SNR}) \\
 = 1 \times 10^6 \times \log_2(1 + 251) \\
 = 8 \text{ Mb/s} \\
 \\
 \text{Nyquist:} \\
 C = 2B \log_2(m) \\
 8 \times 10^6 = 2 \times 10^6 \times \log_2(m) \\
 \log_2(m) = 4 \\
 m = 16 \\
 \\
 \begin{array}{l}
 S = 502 \text{ mW} \\
 N = 2 \text{ mW} \\
 \text{SNR} = \frac{S}{N} \\
 = \frac{502 \text{ mW}}{2 \text{ mW}} \\
 = 251
 \end{array}
 \end{array}$$

Figure 18: Shannon Capacity Example; Lecture 05