EE 302 PS 22 - SOLUTIONS

Chapter 11

Questions: None
Problems: 2, 5, 6, 7
Critical Thinking: None

Additional Problems: 1-5

Problem 2

$$\frac{70\ \mu\text{s}}{1\text{bit}} \longrightarrow \text{data rate} = \frac{1\text{bit}}{70\ \mu\text{s}} = 14.286\ \text{kbps}$$

Problem 5

$$C = 2B = 2(30\ \text{kHz}) = 60\ \text{kbps}$$

Problem 6

$$C = 2B\log_2 N = 2(30\ \text{kHz})\log_2 8 = 2(30\ \text{kHz})\frac{\log_{10} 8}{\log_{10} 2} = 180\ \text{kbps}$$

Problem 7

Recall that in the capacity formula for a noisy channel, SNR is a ratio, not a dB value:

$$C = B\log_2(1 + \text{SNR})$$

Therefore, we must convert the 28 dB to a power ratio:

$$\text{SNR} = 10^{\text{SNR}_{dB}/10} = 10^{28/10} = 630.96$$

$$C = B\log_2(1 + \text{SNR}) = (15\ \text{MHz})\log_2 631.96 = 139.56\ \text{Mbps}$$

Additional Problem 1

At the very least, we need one unique binary word for each symbol. There are four symbols. A combination of two bits will yield four unique binary words, so two bits are required to represent the four symbols.

Additional Problem 2

Two bits yield four unique words. Three bits yield eight unique words, so three bits are required to uniquely represent five symbols.

Additional Problem 3

$$\log_2 4 = 2$$

$$\log_2 5 = 2.32$$

For five symbols, more than two bits are required, and three bits is more than enough. We need to round the result of the $\log_2$ operation up to 3 bits (three bits are required).

Additional Problem 4

To uniquely represent 5,000 different characters using binary words, we require:

$$\log_2 5,000 = 12.29 \text{ bits}$$

This calls for 13 bits. Since we're asking for bytes, however, one byte is not enough. Two bytes are required.

Additional Problem 5

Assume a document with N words. Note that the ASCII coding system uses seven bits to represent the English alphabet (capital letters, lower-case letters, numerals, punctuation, and delimiters).
English:

$$\left(\frac{N \text{ words}}{1}\right)\left(\frac{4.5 \text{ letters}}{1 \text{ word}}\right)\left(\frac{7 \text{ bits}}{1 \text{ letter}}\right)\left(\frac{1 \text{ byte}}{8 \text{ bits}}\right) = 3.94N \text{ bytes}$$

Chinese:

$$\left(\frac{N \text{ words}}{1}\right)\left(\frac{2 \text{ characters}}{1 \text{ word}}\right)\left(\frac{13 \text{ bits}}{1 \text{ character}}\right)\left(\frac{1 \text{ byte}}{8 \text{ bits}}\right) = 3.25N \text{ bytes}$$

Thus, the Chinese document is likely to require less storage.