ECE 2305 – D-term 2011
Homework 3 Solutions

1. Bit rate and bandwidth are not equal because:

- + There are many different definitions of bandwidth, but really only one definition of bit rate. Thus, equating them is meaningless.
- + Only with binary signaling (i.e. one bit per Hertz) and a very specific definition of bandwidth could one argue that bit rate and bandwidth are equal. However, not all communication systems use binary signaling. In fact, most modern communication systems use much higher-order signals (i.e. more than 2 levels).
- + As Freeman says, "The data rate that bandwidth can support is determined by several factors such as the modulation waveform employed, the group delay of the medium inside certain bandwidth constraints, signal level, noise, and type of modulation."

Thus, while bit rate and bandwidth are highly connected, they are not equal.

2. Problem 3.15

Answer:

Using Shannon's equation: $C = B \log_2 (1 + SNR)$

We have $W = 300$ Hz $(SNR)_{dB} = 3$

Therefore, $SNR = 10^{0.3}$

$C = 300 \log_2 (1 + 10^{0.3}) = 300 \log_2 (2.995) = 474$ bps

3. Problem 3.16

Answer:

Using Nyquist's equation: $C = 2B \log_2 M$

We have $C = 9600$ bps

a. $\log_2 M = 4$, because a signal element encodes a 4-bit word

Therefore, $C = 9600 = 2B \times 4$, and $B = 1200$ Hz

b. $9600 = 2B \times 8$, and $B = 600$ Hz

4. Problem 4.2

Answer:

$10 \log (P_o/P_i) = -20$dB; Therefore, $P_o/P_i = 0.01$

For $P_i = 0.5$ Watt, $P_o = 0.005$ Watt

$SNR = 0.005/(4.5 \times 10^{-6}) = 1.11 \times 10^3$

$SNR_{dB} = 10 \log (1.11 \times 10^3) = 30$ dB

5. **Problem 4.11**
Answer:

Distance (km)	Radio (dB)	Wire (dB)
1	–6	–3
2	–12	–6
4	–18	–12
8	–24	–24
16	–30	–48

6. **Problem 4.14**
Answer:
a. From Appendix 3A, $Power_{dBW}$ = 10 log ($Power_W$) = 10 log (50) = 17 dBW
$Power_{dBm}$ = 10 log ($Power_{mW}$) = 10 log (50,000) = 47 dBm
b. Using Equation (4.3),
L_{dB} = 20 log(900 × 10^6) +20 log (100) – 147.56 = 120 + 59.08 +40 – 147.56 = 71.52
Therefore, received power in dBm = 47 – 71.52 = –24.52 dBm
c L_{dB} = 120 + 59.08 +80 – 147.56 =111.52; $P_{r,dBm}$ = 47 – 111.52 = –64.52 dBm
d The antenna gain results in an increase of 3 dB, so that $P_{r,dBm}$ = –61.52 dBm