Problem 4.9

The received signal is, essentially, the same. The received power will increase by a factor of 4.

Problem 4.13

L_{dB} = 20 log(f_{MHz}) + 120 +20 log (d_{km}) + 60 – 147.56
= 20 log (f_{MHz}) +20 log (d_{km}) + 32.44

Problem 4.14

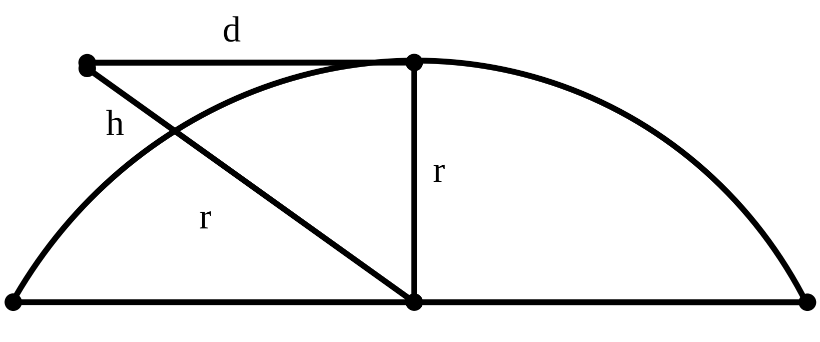
a. Power dBW = 10 log (Power W) = 10 log (50) = 17 dBW
Power dBm = 10 log (Power mW) = 10 log (50,000) = 47 dBm

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 dB
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

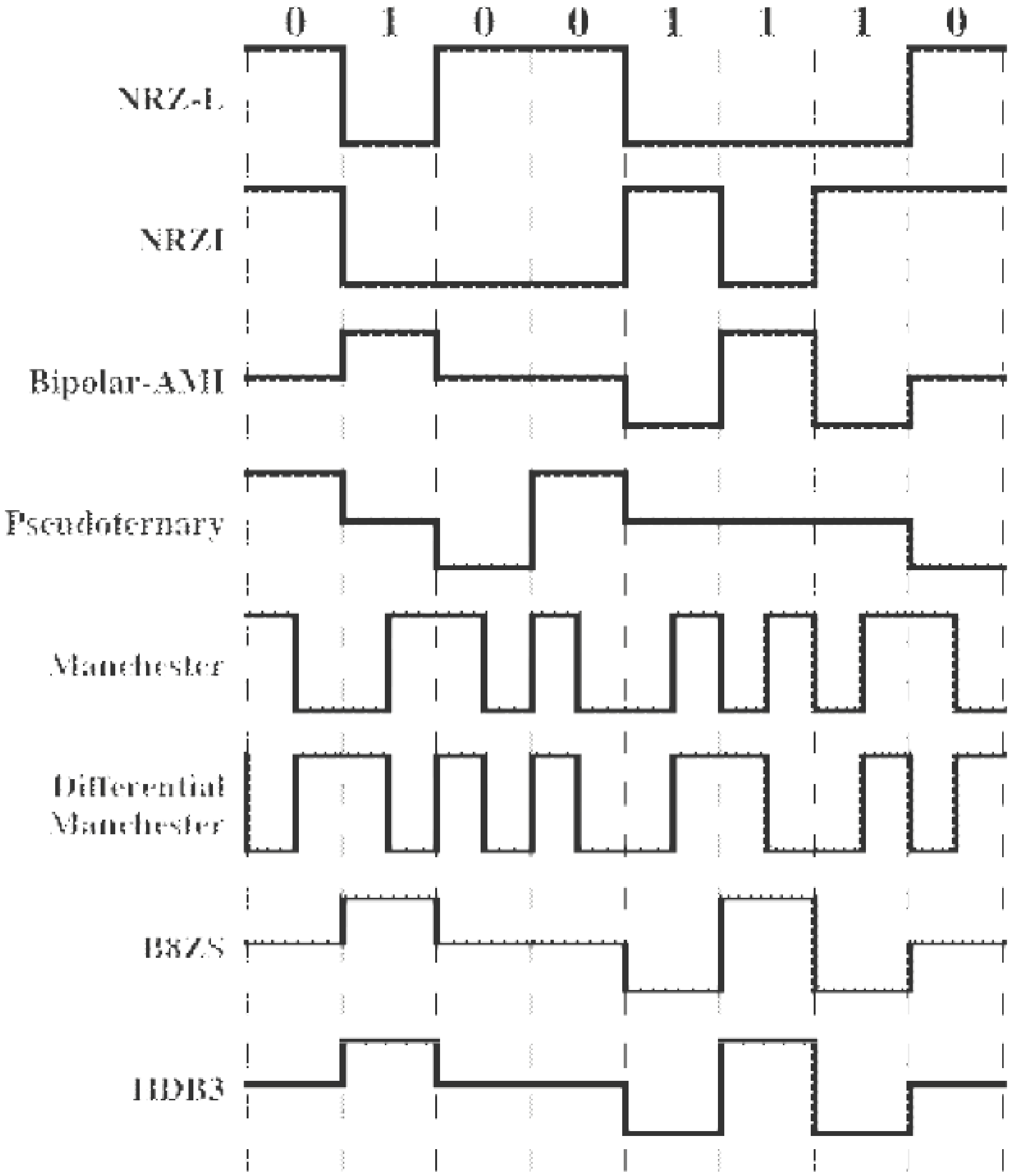
Problem 4.16



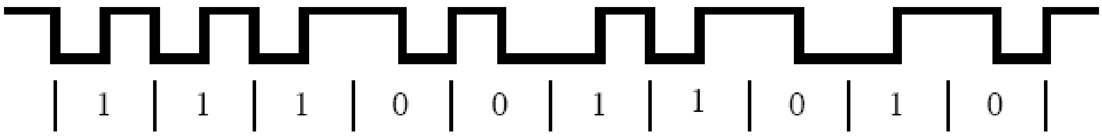
By the Pythagorean Theorem: $d^2 + r^2 = (r + h)^2$
Or, $d^2 = 2rh + h^2$. The h^2 term is negligible with respect to 2rh, so we use $d^2 = 2rh$.

Then, $d_{km} = \sqrt{(2r_{km}h_{km})} = \sqrt{(2r_{km}h_m / 1000)} = 2 \times 6.37 \times h_m = 3.57\ h_m$

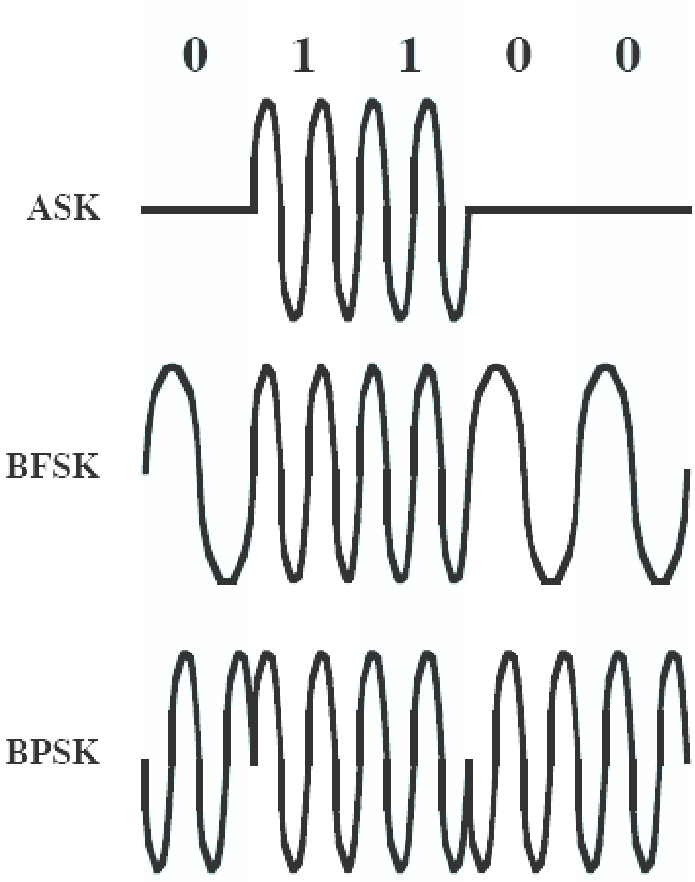
Problem 5.6



Problem 5.7



Problem 5.11



Problem 5.13

Each signal element conveys two bits. First consider NRZ-L. It should be clear that in this case, D = R/2. For the remaining codes, one must first determine the

average number of pulses per bit. For example, for Biphase-M, there is an average of 1.5 pulses per bit. We have a pulse rate of P, which yields a data rate of R = P/1.5
D = P/2 = (1.5 x R)/2 = (0.75).R

Problem 5.20

From the text, $(SNR)_{dB} = 6.02\,n + 1.76$, where n is the number of bits used for quantization. In this case, $(SNR)_{dB} = 60.2 + 1.76 = 61.96$ dB.

Problem 5.21

a. $(SNR)_{dB} = 6.02\,n + 1.76 = 30$ dB
n = (30 – 1.76)/6.02 = 4.69
Rounded off, n = 5 bits
This yields $2^5 = 32$ quantization levels

b. R = 7000 samples/s * 5 bits/sample = 35 Kbps