Using Q-tables

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You are asked to find out what value of E_b/N_0 is necessary to have a bit error rate of 10^{-4} in the case of BPSK. We know that the bit error rate in BPSK is given by

$$P_e = \frac{1}{2}\text{erfc}(\sqrt{E_b/N_0}) = Q(\sqrt{2E_b/N_0}) \tag{1}$$

So, here we go:

$$Q(\sqrt{2E_b/N_0}) \quad = \quad 10^{-4} \tag{2}$$

Check the Q-tables to see where you can find 10^{-4}. Unfortunately, the Q-tables have entries only till 1.963×10^{-4}. This is the last entry in the Q-tables (Row corresponding to the entry 3.5 and column corresponding to 0.045). So let us assume that this is sufficient for our purposes. That is,

$$Q(3.5 + 0.045) \approx 10^{-4} \tag{3}$$

This means $\sqrt{2E_b/N_0} = 3.545$. Or $2E_b/N_0 = 12.567$. Or $E_b/N_0 = 6.2835$. In dB, this is:

$$E_b/N_0 = 10 \log_{10} 6.2835 = 7.98 \text{ dB} \tag{4}$$

The more accurate answer is of course 8.4 dB as shown in the slides.

You can get a fairly accurate answer if the probability of error was less than 1.96×10^{-4}. For example, what E_b/N_0 would you need to have a bit error rate of say 2×10^{-3} ? Compare the answers you get from the Q-tables and from Matlab.