Telecommunications II Tutorials

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Tutorials from [1]

1. 6.2, 6.4, 6.6, 6.7, 6.8, 6.11, 6.12, 6.13, 6.14, 6.15, 6.17, 6.19(b), 6.20
2. 7.1, 7.5, 7.6, 7.8, 7.9, 7.10, 7.11, 7.12, 7.13, 7.14, 7.15, 7.16, 7.17, 7.18, 7.19, 7.21, 7.22, 7.25, 7.26
3. 8.1, 8.2, 8.9(a), (c), (d), 8.10, 8.13, 8.16, 8.17, 8.18, 8.19, 8.21, 8.22, 8.23, 8.24, 8.29
4. 10.1, 10.2, 10.3, 10.5, 10.8, 10.10, 10.11, 10.12, 10.14, 10.15, 10.16, 10.17, 10.18, 10.19, 10.20, 10.22, 10.23

Tutorials from [2]

1. 6.2-4, 6.2-5, 6.2-6, 6.2-7, 6.2-8, 6.2-9

More to follow ....

References

[1] S. Haykin, *Digital Communications*, John Wiley & Sons, third edition, 1988.

[2] B.P. Lathi, *Modern Digital and Analog Communication Systems*, Oxford University Press, third edition, 1998.

Hints to solve questions

Haykin 6.2

Parts a, b and c: Find the highest frequency component and multiply by 2 to get the Nyquist rate. The Nyquist interval is the inverse of the Nyquist rate.

Haykin 6.4

Using matlab plot $1/\text{sinc}(0.5T/T_s)$ versus T/T_s. From your program determine the required equalisation. Remember that $1/\text{sinc}(0.5T/T_s)$ should ideally be 1.

Haykin 6.6

Parts a and b: Divide the sampling period by the number of channels +1. This gives the time span from one pass to the next pulse. Subtract the pulse duration from the time span.

Haykin 6.7

(a) Simply multiply the number of channels by bandwith.

(b) The Nyquist rate for each channel is known. Multiply this rate by the number of channels to find the total number of samples per second (total data rate). From the Nyquist sampling theorem, the minimum bandwidth is half the sampling rate.

Haykin 6.11

Use the input/output characteristics given in Figure 6.17.

Haykin 6.12

Use Figure 6.21.

Haykin 6.14

Period is 1 second. Consider 4 samples at $t = 1/8, 3/8, 5/8, 7/8, \ldots$. Find $m(t)$ at these sampling instants. Sketch the input/output characteristics of the midrise quantiser. Bear in mind that in this problem we have a 4 bit PCM system. From your sketch, find the PCM equivalent for $m(t)$ at the above sampling times. From your result, sketch the PCM signal. (Something similar to Figure P6.3)

Haykin 6.15

This problem is exactly the opposite way round to Question 6.14, i.e. from the given PCM signal you want to deduce the sampled version of the desired analogue signal. Make sure you thoroughly understand Question 6.14 before tackling this question.

Haykin 6.17

(a) Bit rate divided by the number of bit in the encoder gives number of samples per second (or sampling frequency). From the Nyquist sampling theorem find the maximum message bandwidth.

(b) The output signal to quantising noise is indendent of the input frequency. Simply use the 6dB rule.

Haykin 6.19

(a) Not included

(b) Simply expand the $(1-2p_1)^n$ term. Bear in mind that p_1 is very small and n is not too large.

Haykin 6.20

Assume $m(t) = A_m \cos(2\pi f_m t)$. Find the maximum slope, and use it in (6.56) to find A_m. Knowing A_m, it is easy to deduce the maximum power.

Haykin 7.1

(a) Find $s(T-t)$.

(b) Convolve $s(t)$ and $s(T-t)$.

(c) Use the result in (b).

Haykin 7.5

Use $P_e = 0.5\text{erfc}(\sqrt{E_b/N_0})$ and $E_b = A^2 T_b$

Haykin 7.6

(a) Use $P_e = 0.5\text{erfc}(\sqrt{E_b/N_0})$ and $E_b = A^2 T_b$ and the fact that $\sigma^2 = \sqrt{N_o/T_b}$.

(b) Total variance = variance of noise + variance of interference. Again use the equations in part (a).

Haykin 7.8

Write a simple program to sketch the waveform. It is difficult to sketch by hand.

Haykin 7.9

$P(f)$ is an even real function. Therefore, its inverse FT simplifies to

$$p(t) = 2\int_0^\infty P(f)\cos(2\pi f t)\text{df}$$

Haykin 7.10

Find R_b. The minimum BW is $1/2T$. Remember that T is the symbol period.

Haykin 7.11

Linear phase response means a constant delay τ must be introduced into $p(t)$. To this end, the slope of the phase response must be multiplied by $-1/2\pi$. See 2.171 page 99.

Haykin 7.12

Find the minimum bandwidth W and then use $W(1+\alpha)$ to determine the transmission bandwith.

Haykin 7.13

$W = 1/2T$, where T is the symbol period. The transmission BW is $W(1+\alpha)$.

Haykin 7.14

(a) $B = (1+\alpha)/2T$. $\alpha = 1 \rightarrow B = 1/T$. B is given. Therefore find $T = 2T_b$. Find R_b.

(b) From R_b the fact that there are 8 bit per symbol, find the sample rate or sampling frequency. Use the Nyquist's theorem for the rest.

Haykin 7.15

From $W(1+\alpha) \leq 75$ kHz, find α.

Haykin 7.16

In duobinary signalling, symbols are not statistically independent.

Haykin 7.17 and 7.18

Use Table 7.1 as an illustrating example to solve these two problems.

Haykin 7.19

(a) Easy. Notice the typing mistake in Figure P7.2.

(b) Find the output to determine the output and hence the number of levels in the output. Haykin 7.21 and 7.22 Use Table 7.1 as an illustrating example to solve these two problems.

Lathi 6.2-4

Maximum quantisation error $\leq 0.2\% m_p = \Delta/2 = 2m_p/2L$. Therefore L can be found. DONOT USE THIS L. From the practical L find the number of bits per sample. For the Nyquist rate for each signal, find, find the actual Nyquist rate. From this and the number of bits per sample, find the bit rate. From this find the actual bit rate. Finally, determine the minimum bandwidth.

Lathi 6.2-5

Find the Nyquist rate for each ECG signal. Then find the sampling rate for each ECG signal. Next find the total samples per second for all ECG signals. Quantisation error $(\Delta/2)$ must be $\leq 0.25\% m_p$. By definition, $\Delta = 2m_p/L$. Therefore, L can be found. DONOT USE THIS L. From the L used in practice, find bits/sample and hence the total bit rate. Find the required bandwidth from the total bit rate.

Lathi 6.2-6

Use the 6-dB rule. Remember this rule is for sinusoidal input signal only.

Lathi 6.2-7

Use Equation (6.43) in Haykin and the Hint given by Lathi.

Haykin 8.1

(a) and (b) Use Example 1 (page 481) and Figure 1 (page 482) an an example to solve this problem.

Haykin 8.9

(a) We will discuss it in class.

(b) Not included.

(c) Set $k^2 = 0.1$. Knowing P_e, one can easily find E_b/N_0.

(d) Knowing P_e, use the expression for BPSK to determine the new E_b/N_0.

Haykin 8.10

Find T_b and, hence, E_b. Knowing E_b and No and the relevant expression for BER, find the actual value of BER for modulation schemes in (a), (b) and (c).

Haykin 8.16

Knowing P_e and N_0, one can easily find E_b from the relevant BER expression. Divide E_b by the given T_b to find the required power.

Haykin 8.17

Use the relevant expressions given in the text.

Haykin 8.18

This question is straightforward.

Haykin 8.19

Use Figure 8.19 as an example to do this question.

Haykin 8.21

By noncoherent MSK, Haykin means noncoherent binary FSK. Use the relevant BER expressions to solve this question.

Haykin 8.22

Use Figure 8.24 as an example to solve this question.

Haykin 8.24

For QPSK $E_s = 2E_b$, otherwise $E_s = E_b$ for other modulation schemes. Use the relevant error rate expressions. We are just expecting a slight degradation in error performance of the coherent QPSK wrt that of coherent PSK and coherent MSK. There won't be any change in the error performance of noncoherent FSK, coherent FSK, coherent BPSK, and coherent MSK.