In the Name of God

Communication Systems (25751-4)

Problem Set 07

Fall Semester 1402-03

Department of Electrical Engineering

Sharif University of Technology

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Due on Dey 9, 1402 at 12:00

1 Manchester Coding

In telecommunication and data storage, Manchester code (also known as phase encoding, or PE) is a line code in which the encoding of each data bit is either low then high, or high then low, for equal time. It is a self-clocking signal with no DC component. An example of Manchester encoding is in Figure 1.

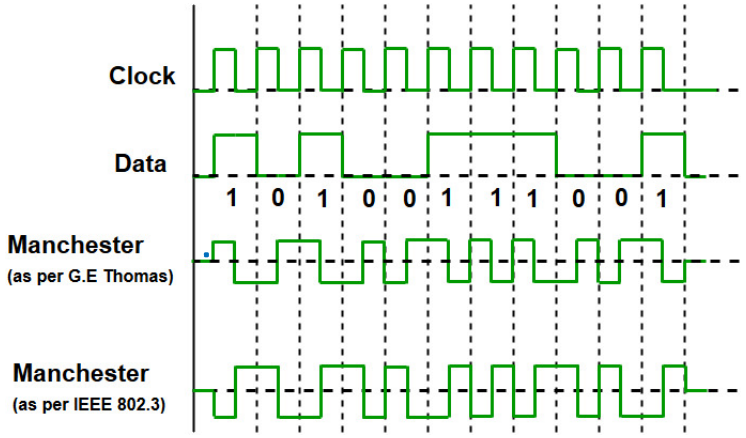

Figure 1: Manchester encoding

A random binary data sequence 101001101 is transmitted using Manchester (G.E. Thomas) line code with the pulse $p(t)$ indicated below.

$$p(t) = \Pi(\frac{t + \frac{T_b}{4}}{\frac{T_b}{2}}) - \Pi(\frac{t - \frac{T_b}{4}}{\frac{T_b}{2}})$$

1. Sketch the waveform $y(t)$.
2. In order to drive $\mathcal{S}_y(\omega)$ first find the Fourier transform of $p(t)$.
3. By assuming equal probability for 1 and 0, calculate R_n.
4. Finally derive the PSD of a Manchester (split phase) signal.
5. Sketch the PSD and Find the effective bandwidth as discussed in the class.

2 Power and Coding

In a bitstream consider that the probability of having a 0 is four times having a 1.

1. Compare the power of bitstreams encoded with:
   (i) Manchester encoding,
   (ii) NRZ (with 0 amplitude for 0),
   (iii) NRZI (with 0 amplitude for 0),
   (iv) AMI (Alternate Mark Inversion, also called Bipolar encoding).
2. For each one of the aforementioned encodings, identify whether it can have problems regarding clock synchronization with:
   (a) Long strings of consecutive 0s
   (b) Long strings of consecutive 1s

3 Bandwidth and Data rate

A leased telephone of bandwidth 4 kHz is used to transmit binary data. Calculate the maximum data rate that can be transmitted if we use:

1. Polar signal with rectangular half-width pulses.
2. Polar signal with rectangular full-width pulses.
3. Polar signal using Nyquist criterion pulses of $r = 0.2$.
4. Bipolar signal with rectangular half-width pulses.
5. Bipolar signal with rectangular full-width pulses.

4 Transmission bandwidth

There are eight analog measurements in a system, each of bandwidth 2 kHz. Samples of these signals are time-division multiplexed, quantized, and binary coded. The error in sample amplitudes cannot be greater than 1% of the peak amplitude.

1. Determine L, the number of quantization levels.
2. Find the transmission bandwidth B_T if Nyquist criterion pulses with roll-off factor $r = 0.2$ are used. The sampling rate must be at least 25% above the Nyquist rate.

5 Nyquist Criterion

The Fourier transform $P(f)$ of the basic pulse $p(t)$ used in a certain binary communication system is indicated below.

$$P(f) = 10^{-6}\Lambda(\frac{f}{10^6})$$

1. From the shape of $P(f)$, explain if this pulse satisfies the Nyquist criterion.
2. Find $p(t)$ and verify that this pulse does (or does not) satisfy the Nyquist criterion.
3. If the pulse does satisfy the Nyquist criterion, determine the transmission rate and the roll-off factor.