Solutions to Assignment 2

Question 1

The group delay variation should be significantly less than the symbol period to avoid ISI. If the symbol rate is 1 MHz, the symbol period is 1 μs and the channel group delay variation should be significantly less than this. An RF amplifier with a group delay variation of up to 1 μs would result in significant ISI and would not be suitable.

Question 2

THD is defined as:

$$\text{THD} = \sqrt{\frac{P_1 + P_2 + P3 + \ldots}{P_0}}$$

where the P_i it the power of the i'th harmonic and P_0 is the power of the fundamental.

The following table shows the computation of the power of the fundamental, of the harmonics, and the THD (about 37%):

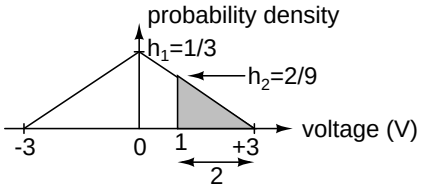
i	P(i) (dB)	P(i) (W)
0	0	1
1	-15	0.032
2	-10	0.100
3	-30	0.001
4	-25	0.003
sum(i=1 to 4)		0.136
THD=		37%

Question 3

(a) The integral of a probability density is unitless so the units on the vertical axis should be $\frac{1}{\text{volts}}$.

(b) The area under the probability density curve is always 1 (the signal must always have some voltage).

(c) The probability that the noise level is greater than 1 is the area under the curve to the right of 1. This is the area of the shaded triangle shown below:



The maximum of the curve (h_1) can be found by equating the area of the curve (two triangles) to one: $2 \times \frac{1}{2} \times 3 \times h_1 = 1$ or $h_1 = \frac{1}{3}$.

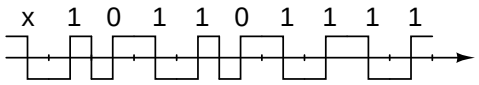
The height of the shaded triangle can be found using the ratio of the triangle widths and heights: $h_1/3 = h_2/2$ or $h_2 = \frac{2\times1}{3\times3} = 2/9$.

The probability of the noise being greater than 1 V is the area of the shaded rectangle or $\frac{1}{2} \times 2 \times \frac{2}{9} = \frac{2}{9} \approx 22\%$.

Question 4

Differential encoding encodes a '1' as a change from the previous symbol and '0' as no change. For a Manchester line code there are two symbols: low-to-high and high-to-low.

Differential Manchester line coding encodes each 1 as the opposite transition as the previous symbol and each 0 as the same transition as the previous symbol. The waveform would thus look as follows for the bit sequence 1011 0111 if the previous symbol was a high-to-low transition:



Question 5

The equation for a sine wave with an amplitude of 1 V and a frequency of 1 kHz is $v(t) = \sin(2\pi ft) = \sin(2\pi 1000t)$.

The slew rate is the derivative with respect to time. This is $2\pi f \cos(2\pi ft)$ and has a maximum value of $2\pi f = 6283$ V/s at $t = 0$.