Solutions to Midterm Exams

Midterm 1, Question 1

During the exam students were asked to assume that there were 7 bits/character.

The one positive pulse includes a start bit, '0' data bits when the signal is high, '1' data bits when the signal is low and one stop bit (also low).

(a) In one version of the question the bit rate was 4800 bps so the 1250 μs pulse contained $4800 \times 1250 \times 10^{-6} = 6$ high bits. This is interpreted as one start, five data 0's, two data 1's and one stop bit.

In the other version of the question the pulse contained $9600 \times 729 \times 10^{-6} = 7$ high bits. This is interpreted as one start, 6 data 0's, 1 data 1 and one stop bit.

Thus the seven data bits in order from MS to LS would be 110 0000 (0x60) in the first version and 100 0000 (0x40) in the second version.

(b) The values are both less than 0x7f so the corresponding Unicode characters are found in the table at the end of Lecture 1. These are a backquote (`, 0x60) and an 'at' sign (@, 0x40).

(c) The parity bit would have been low (1) so the number of 1 bits in the first version would have been 3 (odd parity) and 2 (even parity) in the second version.

Midterm 1, Question 2

The question asks for distance at which the received power, $P_R = 1\,\mu$W and we are given P_T, $G_T = G_R = 1$ and f. So we can solve the Friis equation for d and substitute $\lambda = c/f$:

$$d = \frac{c}{4\pi f}\sqrt{\frac{P_T G_T G_R}{P_R}}$$

In one version of the question $P_T = 10$ W and $f = 300$ MHz. In this case $d = \frac{3\times10^8}{4\pi\times300\times10^6}\sqrt{10\times10^6} \approx 252$ m.

In the second version of the question $P_T = 1$ W and $f = 3$ GHz. In this case $d = \frac{3\times10^8}{4\pi\times3\times10^9}\sqrt{1\times10^6} \approx 8$ m.

Midterm 2, Question 1

(a) The channel has high attenuation at low and high frequency so this is a bandpass channel.

(b) -6 dB corresponds to a voltage ratio of $10^{\frac{-6}{20}} \approx 0.5$. In one version of the question the channel reaches 0.5 times the maximum value ($= 1$) at frequencies of 15 and 25 kHz result in a bandwidth of $25 - 15 = 10$ kHz. In the other version these frequencies are 7.5 and 12.5 for a bandwidth of 5 kHz.

(c) Since the phase varies linearly with frequency this is a linear-phase channel and the delay is the same at all frequencies. We can solve the equation given in the notes for the delay (τ) as:

$$\tau = \frac{\Delta\theta}{-2\pi f}$$

We can use the first section of the curve to obtain the delay.

In one version of the question the change in phase is $-\pi$ in 10 kHz so the delay is $\tau = \frac{-\pi}{-2\pi 10\times10^3} = 50\,\mu$s.

In the other version of the question the change in phase is $-\pi$ in 5 kHz so the delay is $\tau = \frac{-\pi}{-2\pi 5\times10^3} = 100\,\mu$s.

(d) (i) The magnitude of the transfer function gives the ratio of the output to input voltage. In both versions of the question, at the frequency given in the question (7.5 or 15 kHz), the magnitude of the transfer function was 0.5. In one version of the question the input level was 100 mV and so the output level would be 50 mV. In the other version the input level was 200 mV so the output level would be 100 mV.

(ii) The angle (argument) of the transfer function is the difference between the output phase and the input phase. In both versions of the question, at the frequency given in the question (7.5 or 15 kHz), the argument of the transfer function was 90 degrees ($\frac{\pi}{2}$) and this is the phase shift from the input to the output (the output phase minus the input phase).

Midterm 2, Question 2

For the AMI-RZ line code a '1' is encoded as a pulse and a '0' as no pulse. The polarities of the pulses alternate.

(a) In the first version of the question the bits transmitted, in time order were: 1, 1, 0, 0, 1, 0, 1, 0. In the second version they were: 1, 1, 0, 1, 0, 1, 0, 0.

(b) There is a coding violation if two consecutive pulses have the same polarity. In the first version of the question there is a coding violation in the fifth bit (bit 4) because this bit is the same polarity as the second bit (bit 1). In the second version of the question there is a coding violation in the fourth bit (bit 3) because it has the same polarity as the second bit (bit 1).

(c) If the bits had been transmitted in lsb-first order, the byte values would have been $0101\ 0011_2$ (0x53) for the first version and $0010\ 1011_2$(0x2b) for the second version of the question.