Solutions to Mid-Term Exam

Question 1

The two bytes, `0xd0` and `0xaf` in binary would be: 1101 0000 and 1010 1111. To decode the sequence note that the MS three bits of the first byte (110) match the MS bits of the first byte on the second line:

Table 3-6. UTF-8 Bit Distribution

Scalar Value	First Byte	Second Byte	Third Byte	Fourth Byte
00000000 0xxxxxxx	0xxxxxxx			
00000yyy yyxxxxxx	110yyyyy	10xxxxxx		
zzzzyyyy yyxxxxxx	1110zzzz	10yyyyyy	10xxxxxx	
000uuuuu zzzzyyyy yyxxxxxx	11110uuu	10uuzzzz	10yyyyyy	10xxxxxx

We must therefore divide the remaining bits according to this row. The five bits labelled yyyyyy are 1 0000 and six bits labelled x are 10 1111. Combining these two gives us the 11-bit number 1 00 00 10 1111 which is the Unicode code point of the character, 0x42f.

Question 2

A communication system transmitting data using 16 different symbols can transmit $\log_2(16) = 4$ bits/symbol.

(a) If one symbol is transmitted every T seconds the symbol rate is $1/T$. For $T = 1\,\mu$s the symbol rate is 1 MHz, for $T = 2\,\mu$s the symbol rate is 500 kHz.

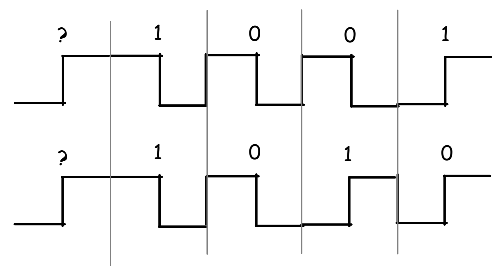
(b) The bit rate is the symbol rate times the number of bits per symbol which would be 4 Mb/s and 2 Mb/s respectively.

(c) The baud rate is the minimum time between signal level transitions. Assuming the level does not change between symbols, the baud rate would be the same as the symbol rate (1 MHz or 500 kHz).

Question 3

A differential Manchester line code, as described in the lecture notes, transmits a different symbol than the previous one to encode a '1' and transmits the same symbol as the previous one to transmit a '0'. Each symbol consists of a low-to-high or a high-to-low transition.

If the previous symbol contained a low-to-high transition the transmitted waveforms for the bits 1001 and 1010 would be:



Question 4

(a) The dielectric constant of the dielectric can be found from the equation relating the characteristic impedance of the cable (given as 50 Ω), the dielectric constant ε_r, and the shield and inner conductor diameters ($D = 5$ mm and $d = 2.5$ mm respectively).

$$\varepsilon_r \approx \left(\frac{60}{Z_0}\ln\left(\frac{D}{d}\right)\right)^2 = \left(\frac{60}{50}\ln\left(\frac{5}{2.5}\right)\right)^2 \approx 0.69$$

Note that this is not physically possible (Z_0 could not be 50 Ω with these dimensions).

(b) The propagation delay can be found as the length of the cable divided by the velocity of propagation which in turn can be found as $\mathrm{VF} = \frac{1}{\sqrt{\varepsilon_r}} \approx 1.2$ and $v = c \times \mathrm{VF} = 3.6 \times 10^8$ (which is also not possible).

For a 1 m-long cable the delay is $\frac{1}{3.6\times10^8}$ =2.77 ns and for a 2 m-long cable it twice that or about 5.55 ns.

Question 5

If an error happens when the noise voltage is greater than v, then the error rate is the probability that the signal exceeds this voltage. If the mean (the DC voltage) is $\mu = 0$ V and the standard deviation (the rms voltage) is σ, then the normalized threshold is $t = \frac{v-\mu}{\sigma}$ and the probability that the signal *exceeds* this voltage is $1 - P(t)$. There were two versions of the question ($v = 0.3$ with $\sigma = 0.1$ and $v = 0.6$ with $\sigma = 0.2$) both of which result in $t = 3$. $P(3)$ can be found using a calculator (0.9985), the graph in Lecture 4 (about 0.998) or the logistic approximation $\frac{1}{1+e^{-1.7\times 3}} = 0.994$ which gives an error rate of about 0.2% (or 0.6% with the approximation formula).