Solutions to Final Exam

Question 1

The chart shows the Unicode code point is U+00B5 for µ and U+00C6 for Æ.

(a) From Table 3-6 in the Unicode standard, 2 bytes are required for the UTF-8 encoding of character with code points of the form 0000 0yyy yyxx xxxx (between 8 and 11 non-zero bits).

(b) The UTF-8 encoding is 110 yyyyy for the first byte and 10 xxxxxx for the second.

U+00B5 is 0000 0000 1011 0101 in binary. Thus yyy yy is 000 10 and xx xxxx is 11 0101.

The UTF-8 encoding is thus 110 0 0010 (0xc2) for the first byte and 10 11 0101 (0xb5) for the second byte.

U+00C6 is 0000 0000 1100 0110 in binary. Thus yyy yy is 000 11 and xx xxxx is 00 0110.

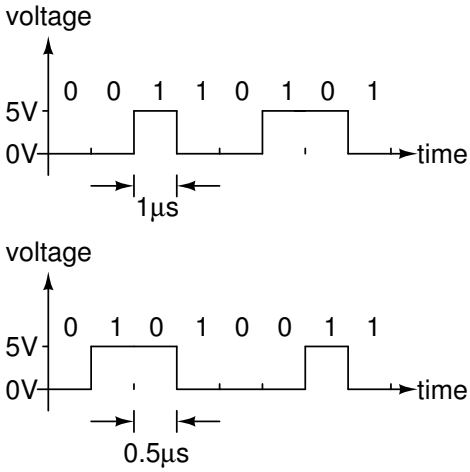
The UTF-8 encoding is thus 110 0 0011 (0xc3) for the first byte and 10 00 0110 (0x86) for the second byte.

(c) If the first byte is 0xc2 1100 0010 then in l.s.b.-first order the bits are 0,1,0,0, 0,0,1,1. If the first byte is 0xc3 1100 0011 then in l.s.b.-first order the bits are 1,1,0,0, 0,0,1,1.

Question 2

The bits to be transmitted are 0011 0101 for 0x35 and 0101 0011 for 0x53. The unipolar NRZI line code uses two levels (0 and 5V in this question) and encodes a 1 as a transition and a 0 as no transition.

If the previous bit was transmitted as a zero level then the 1 and 2 Mb/s waveforms would be:



Question 3

The capacity of a channel is the information rate that allows (but does not ensure) error-free transfer of information. The question requires this capacity to be 1 Mb/s. For an AWGN channel the capacity is a function of channel bandwidth, B, and the SNR:

$$C = B\log_2(1+\frac{S}{N})$$

so that

$$B = \frac{C}{\log_2(1+\frac{S}{N})}$$

If the signal power is 100 μW and the additive white Gaussian noise power is 33 μW then the SNR is $\frac{100}{33} \approx 3$. If the signal power is 200 μW and the additive white Gaussian noise power is 66 μW the SNR is also 3.

For a capacity of 1 Mb/s the required bandwidth is $B = \frac{1\times10^6}{2} = 500$ kHz since $\log_2(1+3) = \log_2(4) = 2$. Similarly, for a capacity of 2 Mb/s the required bandwidth is $\frac{2\times10^2}{2} = 1$ MHz.

Question 4

PPP-style framing uses a 0x7e "flag" byte to delimit the frame and the 0x7d byte to escape characters. From the sequence of characters below:

`0xaa 0x7e 0x7d 0x7e 0xe7 0x27 0x00 0x7e 0x1b`

we ignore the 0xaa which appears before the first flag character. The flag character is not part of the frame. The 0x7d is the escape character to the subsequent character (0x7e) is taken literally rather than as the terminating flag character. The frame ends with the next un-escaped flag character (0xe7). Thus the contents of the frame are:

`0x7e 0xe7 0x27 0x00`

Question 5

(a) The Hamming distances between the codewords are:

	101100	010110	001011
101100	0	4	4
010110		0	4
001011			0

and the minimum is $d = 4$.

(b) the maximum number of errors the code is guaranteed to detect is $d - 1 = 3$.

(c) the maximum number of errors the code is guaranteed to correct is $\lfloor \frac{d-1}{2} \rfloor = \lfloor \frac{3}{2} \rfloor = 1$

(d) since the received codeword does not match any of the valid codewords then the channel must have introduced an error. Comparing the received codeword to each of the valid codewords the distances are:

	010111	110110
101100	5	3
010110	1	1
001011	3	5

So if 010111 was received then 010110 was most likely transmitted and the last bit was most likely received in error. If 110110 was received then 010110 was most likely transmitted and the first bit was most likely in error.

Question 6

For the Ethernet frame:

`08 00 27 da fa 8f 00 1d 7e 2f b5 9b 08 00 45 00`

(a) The destination address is the first six bytes: 08:00:27:da:fa:8f.

(b) The OUI of the source address is the first three bytes of the source address (which is the second six bytes): 00:1d:7e.

(c) Since the value of the type/length field is more than 1500 then the length of the frame is determined by the physical layer. If the length field were a length field it would refer to the payload portion exclusive of the header and padding (2 bytes in this case). However, the length value determined by the physical layer could include the header (16 bytes in this case). The frame might also have been padded to a minimum length. Any similar answer was accepted.