ITS 323 – QUIZ 3 ANSWERS

First name: _____ Last name: _____

ID: _____ Total Marks: _____
out of 10

In all questions, assume bits are number left to right. That is, for the sequence 010111, the first bit is 0, the second bit is 1, the third bit is 0 and the sixth bit is 1.

Question 1 [2 marks]

Consider a simplified CRC error detection algorithm where there are *k* bits of data to send, the frame check sequence (which is appended to the end of the data) is *f* bits in length, and the divisor must be (*f* + 1) bits in length. If the frame to be transmitted is 001101100, which includes the 4 bit FCS:

a) What is a possible value (in binary) of the divisor? [1 mark]

b) If the first two bits of the FCS are received in error, can the receiver detect the errors? Show your calculations. [1 mark]

Answer

a. The divisor must be 5 bits in length (since FCS is 4). The Tx value is 108, so possible divisors are all factors of 108 less than 31 (e.g. 2, 3, 4, 6, 9, 12, …)

b. If the first two bits of FCS are in error, then 001100000 = 96 is received. If divisor was 12, then no error detected. If divisor was 9, then error detected.

Question 2 [4 marks]

a) Which technique is designed for sending analog data as an analog signal? (select only one)

   a. Pulse Code Modulation
   b. Amplitude Modulation
   c. Delta Modulation
   d. Manchester Encoding
   e. NRZ Invert on Ones
   f. Frequency Shift Keying

b) Choosing a very long time-out interval for an ARQ protocol may lead to low throughput because there will be many unnecessary retransmissions (that is, an ACK for original frame is received after original frame is retransmitted).

True / False

c) The highest frequency component of an analog data is 2MHz. If Pulse Code Modulation with each code represented as 4 bits is used, following the sampling theorem, the data rate should be:

   a. 250kb/s
   b. 1Mb/s

c. 2Mb/s

d. 4Mb/s

e. 8Mb/s

f. 16Mb/s

g. 32Mb/s

d) A receiver using the sliding window mechanism has a buffer size of 63000 bytes. Assume each frame is 1000 bytes in length. How many bits should be used to represent the sequence number carried in the header?

a. 1 bit

b. 2 bits

c. 5 bits

d. 6 bits

e. 7 bits

f. 63 bits

g. 64 bits

Answer

Amplitude Modulation

False. With a very long timeout interval, it is unlikely the ACK of the original frame will be received after the timeout (and hence an unnecessary retransmission). (Note that a very long timeout may result in reduced throughput, but no because of the reason stated).

16Mb/s. The sampling theorem says you should sample at at least twice the rate of the highest frequency component (2 x 2Mhz = 4000000 samples per second). Each sample contains a single code, which contains 4 bits. Data rate will 16Mb/s.

6 bits. The maximum window size is 2^k-1 where k is the number of bits in the sequence number. The receiver must be able to receive the maximum window full of frames before sending an ACK, hence needs a buffer size to store at least 2^k-1 frames.

Question 3 [3 marks]

What is the propagation time if using Stop and Wait Flow Control protocol gives a maximum throughput of 125Mb/s.

You can assume:

- Data rate is 1Gb/s
- Data frame size is 9000 bits of data plus 1000 bits of header
- ACK size is 2000 bits
- No processing delay

Answer:

Total time for transmission of data is: DataTransmission + Propagation + Processing + AckTransmission + Propagation

DataTransmission: 10000 / 1Gb/s = 10us

AckTransmission = 2us

Processing = 0ms

Total time = 12 + 2x us

Efficiency = 0.125 = 9 / (12+2x)

12+2x = 72

x = 30 us

Question 4 [1 mark]

Go-Back-N ARQ with a *k* bit sequence number limits the maximum window size to 2^k-1. Explain a problem that may occur if the maximum window size was *greater than* 2^k (e.g. 2^k+1). (A diagram may help with your explanation).

Answer:

With a *k* bit sequence number, the range of numbers are: 0, 1, 2, …, 2^k-2, 2^k-1, 0, 1, …

If the window is larger than 2^k, then the window may encompass frames with the same sequence number (say, *i*). The problem with this is that when an ACK is returned with number (*i*+1), the source cannot be certain which frame the ACK acknowledges: the first frame with sequence number *i* or the second frame with the sequence number *i*?

Example: *k* = 2, window size is 5.

Sequence numbers:	0	1	2	3	0	1	2	3	0	…
Possible window		1	2	3	0	1				

If an ACK with number 2 is returned, does it acknowledge the first frame with sequence number 1 or the second frame with sequence number 1? This ambiguity should be not be present in a protocol.