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 data to send is 0011 and the divisor is 111:

a) What is the value (in binary) of the frame check sequence? [1 mark]

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

Answer

a. The frame check sequence (FCS) must be two bits in length (since divisor is 3 bits). Therefore the transmitted data is: 0011xx where xx = FCS = 10. This results in transmitted data of 001110 = 14, which is divisible by the divisor (111 = 7).

b. If the last two bits are in error, then 001101 = 13 is received. Since 13 is not divisible by 7, then an error is detected.

Question 2 [4 marks]

a) Assume a Hamming distance based forward error correction algorithm is used on a data block of 32 bits, and produces 40-bit codewords. If you instead increase the codeword size to 50 bits, in general, more errors can be detected.

True / False

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) If a protocol uses an 8-bit field in the header for sequence numbers of frames (and all frames are the same size), according to the sliding window mechanism, the minimum number of frames a receiver should be able to store in its receive buffer is:

  a. 1 frame
  b. 2 frames
  c. 8 frames
  d. 254 frames
  e. 255 frames
  f. 256 frames

Answer

True. A larger codeword (relative to the data) means there is a greater chance that, if the codeword has errors, then it will be different from one of the valid codewords. A received codeword different from a valid codeword indicates an error.

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.

255 frames. 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 maximum throughput of the Stop and Wait Flow Control protocol.

You can assume:

- Data rate is 1Mb/s
- Data frame size is 9000 bits of data plus 1000 bits of header
- ACK size is 100 bits
- Propagation time is 20msec
- No processing delay

Answer:

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

DataTransmission: 10000 / 1Mb/s = 10ms

AckTransmission = 0.1ms

Propagation = 20ms

Processing = 0ms

Throughput = 9000 bits / (10 + 20 + 0 + 0.1 + 20) ms

≈ 9000 / 50 ms

= 180kb/s

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.