Cpr E 489 Spring 2024

Midterm Exam

Exam Time: 11:00 AM ~ 12:15 PM, March 7, 2024 (Thursday)

Print your name here:

Joseph Schmidt

Honor Code Pledge: *"I have neither given nor received aid in this exam, nor have I concealed any violations of the honor code."*

Sign your name here:

Joseph Schmidt

- There are three (3) big questions for a total of 100 points.
- This is an open-books, open-references, open-notes, and open-assignments examination.
- Is calculator allowed: Yes.
- Is laptop allowed: Yes, to check notes (but cannot be used to browse the Internet).
- Write your answers and all your work in the space provided.

Question 1	46
Question 2	30
Question 3	24
Total	100

+46

1. (46 points) Give a short answer to each of the following questions:

   a. (6 points) Briefly explain the key differences between message switching and packet switching transfer modes.

Message switching sends the entire (with a max size) message while packet switching breaks the message down into packets. Packet switching is more fair as a small message doesn't have to wait for an entire huge message to be sent as it's broken into packets so the long message can send a packet then the small message can send it's packet.

   b. (6 points) Briefly explain the key differences between mBnB and mBnT line coding schemes.

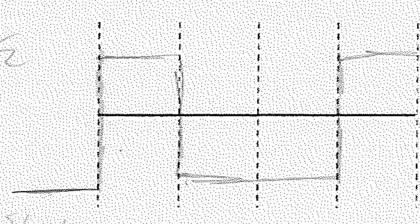
mBnB maps block of m information bits into n pulses. mBnT is the ternary version so instead of the pulses having 2 values like in mBnB binary, pulses will have 3 values.

   c. (6 points) Briefly explain the key differences between 1-persistent and non-persistent options of the CSMA MAC protocol.

1-persistent is more greedy, has more collisons, but has a lower delay. non-persistent is less greedy, fewer collisons, but has a higher delay. This comes from the fact that if the non-persistent protocol sees the channel is not busy it will do a random backoff before trying to send. This is why it's a longer delay less greedy and why there its less collisons.

   d. (7 points) For a stream of four bits: 1101, sketch the waveform for NRZ-Inverted line coding scheme in the figure below. Suppose the waveform in the bit interval prior to 1101 ends at a negative voltage level.

* 1 s flip signal
* 0 do nothing



   e. (7 points) Consider a noisy AWGN communication channel with a channel bandwidth of 100 KHz. The goal is to transmit reliably over this channel at a bit rate of 1 Mbps. Which of the following SNR (Signal to Noise Ratio) is able to accomplish this?

      i. 1100 (absolute value; no unit)
      ii. 30 dB
      iii. Both (i) and (ii)
      iv. None of the above

$C = W \log_2(1+SNR)$
$R = 1$ Mbps
$W = 100$ kHz
$C \geq R = 1$ Mb/s
$W \log_2(1+SNR) \geq R = 1$ Mb/s
$100k \log_2(1+SNR) \geq 1M$
$\log_2(1+SNR) \geq 10$
$1+SNR \geq 2^{10}$
$SNR \geq 1023$

In dB
$10\log_{10}(1023)$
≈ 30.0987 dB
$SNR \geq 30.1$

very close but should be .1 higher to work correctly

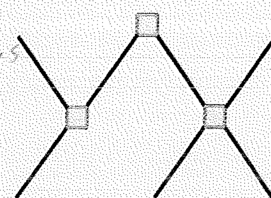
30 dB is not greater than or equal to 30.1 dB

≥ 1023

f. (7 points) An (n, 1) repetition error detection code is defined as follows: each codeword is n-bit long; the first bit of a codeword is a single information bit and the following (n – 1) check bits are repetitions of the information bit. What is the FUE (Fraction of Undetectable Errors) of a (5, 1) repetition code?

i. 1/3
ii. 1/7
iii. 1/15
iv. None of the above

g. (7 points) A CSMA/CD-based half-duplex LAN consists of 7 segments connected by 3 repeaters, as shown in the figure. The maximum length of each segment is 80 meters and the processing delay at each repeater is 1 μs. It transmits at 100 Mbps and signal propagates at $2*10^8$ m/s. What is the minimum frame size required for this CSMA/CD-based half-duplex LAN to operate properly?



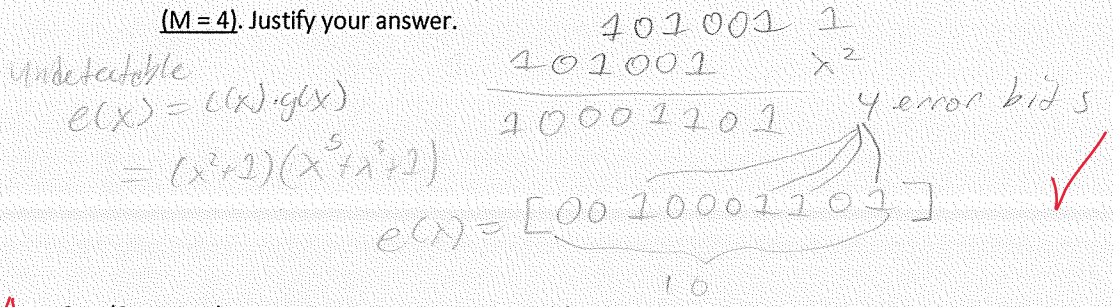
i. 460 bits
ii. 920 bits
iii. 1160 bits
iv. None of the above

2. (30 points) Consider a CRC code with a generator polynomial of $g(x) = x^5 + x^3 + 1$.

a. (10 points) Show step-by-step (using long division) how to find the codeword that corresponds to five information bits of 10110.

b. (10 points) Suppose the codeword length is 10. Give an example error vector of an undetectable error burst of length 8 (L = 8). Justify your answer.

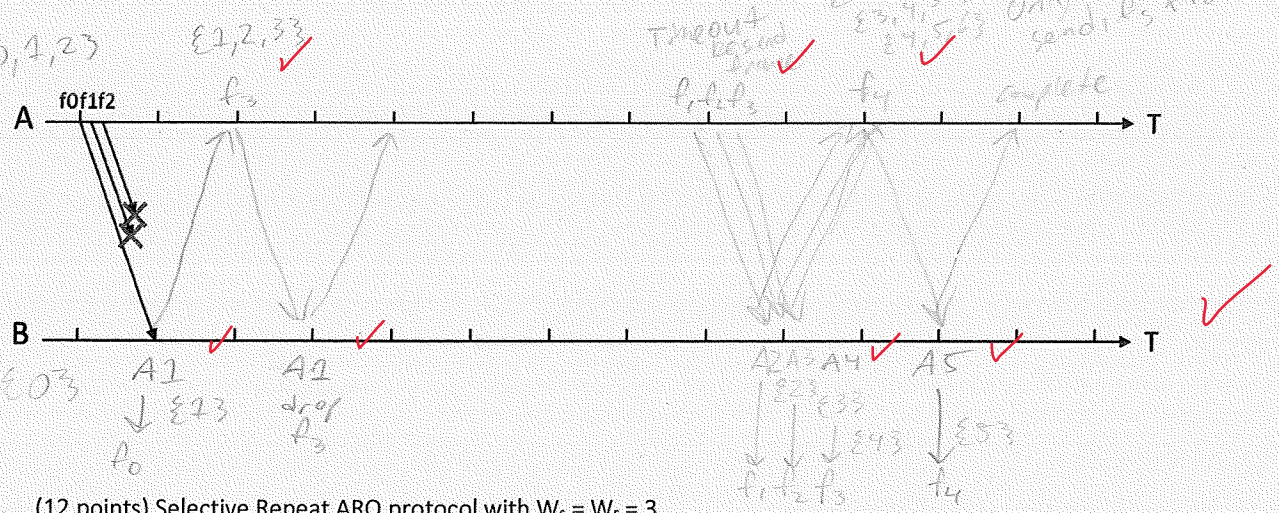
c. (10 points) Suppose the codeword length is 10. Give an example error vector of an undetectable 4-bit error (M = 4). Justify your answer.



+24

3. (24 points) Suppose station A tries to send five data frames (f0, f1, f2, f3, f4) to station B (*i.e., no more frames to send after f4*). Suppose that f1 and f2 are lost on the first attempt, while all other transmissions (including re-transmitted data frames and ACK/NAK frames) succeed. Suppose one-way propagation delay is 1 time unit, and timeout for each data frame is 8 time units. For each of the following ARQ protocols, complete the frame exchange sequence until all five data frames are delivered successfully.

a. (12 points) Go-Back-N ARQ protocol with N = 3.



b. (12 points) Selective Repeat ARQ protocol with $W_s = W_r = 3$.