Instructions

1. The university has important rules for exams. Please carefully read the instructions below. Failure to comply with any of the instructions below may result in our being unable to accept or grade your exam or initiating disciplinary actions
2. The exam must be taken completely alone. Showing it or discussing it with anybody is forbidden, including (but not limited to) the other students in the course in current or previous years. It is also forbidden to use any solutions to similar problems from previous years as reference material.
3. Given your final grade depends on your rank in the class, you don't want to penalize yourself dis- cussing your solutions with the other students.
4. You may use any publicly available material you want, including books, the internet, etc. (You are NOT allowed to submit questions to internet discussion groups, though!).
5. If you find a solution to a test problem in a book or online, cite it in your submission and do not copy it as-is, but make changes that demonstrate you understand what you are writing. Otherwise, we may not accept it.
6. You must submit your exam electronically only in .pdf format via Blackboard no later than 11:59 October 31, 2022. Files submitted after this time will be discarded.
7. Show your work. You need to demonstrate your understanding by showing the detail of your work.
8. Consent: By submitting this exam I declare I am aware of the Kent State Administrative Policy Regarding Student misconduct and I acknowledge that any academic misconduct on this exam will lead to a grade "F" for the course and that the misconduct will be reported to the Center for Student Conduct.

In this exam,

- For convivence use 1 KB = 10^3 bytes, 1 MB = 10^6 bytes, and 1 Mbps = 10^6 bps.
- Stop-and-Wait protocol efficiency = $\frac{1}{1+2\alpha}$, $\alpha = \frac{T_p}{T_f}$
- Sliding window protocol efficiency = $\frac{w}{1+2\alpha}$, where w is the window size.

Name: ……

KSU ID: ……

1. Consider a case in which we organize the data to be transmitted into a 2D array, such that the last row and the last column are even parity bits. 2 Points each

	0	1	2	3	4	5	6	7
0	0	1	1	0	1	0	0	
1	0	1	0	0	0	0	0	
2	1	0	1	0	1	1	1	
3	1	0	1	1	0	1	1	
4	0	1	0	1	1	0	0	
5	0	1	1	1	0	0	0	
6	1	0	0	0	1	1	0	
7								

(a) Calculate the row and column even parity bits.

(b) Prove (show by argument) that 2D parity can detect all 1-bit errors.

(c) Prove (show by argument) that 2D parity can detect all 2-bit errors.

(d) Prove (show by argument) that 2D parity can detect all 3-bit errors.

(e) Prove by counter example (at least two examples) that 2D parity cannot detect some 4-bit errors.

2. 2. We want to transmit an 11-bit message M = $\overleftarrow{11001110110}$ using Hamming code (read the code from right-to-left). 2.5 Points each

(a) How many check bits are needed to ensure that the receiver can detect and correct single-bit error?

(b) Show the bit pattern transmitted for the message. Assume even parity.

(c) Suppose the receiver receives the message, but parity bit p4 (whatever it may be) received in error.

i. How does the receiver find out that the received message has error in it?
ii. ii. How does the receiver knows which bit is in error?
iii. iii. How does the receiver fix the error?

(d) What is the hamming rate?

3. Consider a connection between a sender S and a receiver R where the one-way latency is 512 ms (milliseconds), that the data rate is 1 Mbps, and that each frame size is 4 KB. Assume that S and R are using sliding windows. 2.5 Points each

   (a) Assume that we use Stop-and-Wait protocol, what is the efficiency of the channel?

   (b) Assume that we Sliding Window of 16, what is the efficiency of the channel?

   (c) How large must the window for S be in order to maximize utilization.

   (d) Based on that window size, how many bits must be used in each frame as a frame identifier

4. In CSMA/CD (Ethernet), a station is allowed to transmit data if it senses the carrier free. After undergoing a collision, the station waits for random back off time before transmitting again. After the k^{th} consecutive collisions, each colliding station waits for a random time chosen from the interval $[0, 2^k - 1] * slot - time$. 2.5 Points each

   (a) Is this protocol fair? If yes, how? If no, why?

   Assume that two stations A and B are competing (contending) to capture the channel and they collide. For station A, this is its first collision and for station B this is its 2nd collision.

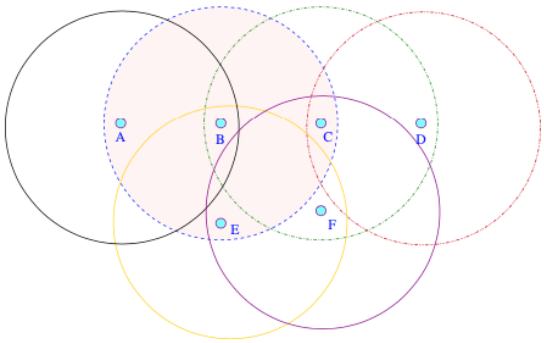
   (b) What is the chance that they collide again?

   (c) What is the minimum delay for each one to transmit its frame? What is the efficiency of the channel (1-% idle time) in this particular scenario?

   (d) What is the maximum delay for each one to transmit its frame? What is the efficiency of the channel (1-% idle time) in this particular scenario?

5. Consider the following wireless network with transmission range of a node is shown by a circle. Assume that two nodes directly interfere with each other (if they are within each other's transmission range.

2.5 Points each



(a) When node B transmits to node E, list all potential hidden nodes and exposed nodes in all directions.

(b) When node C transmits to node F, list all potential hidden nodes and exposed nodes in all directions.

(c) How does RTS/CTS would prevent a hidden node from interfering the sender?

(d) How does RTS/CTS would allow exposed nodes to transmit safely to other destinations.

6. Briefly describe, 2.5 Points each

(a) Bit-oriented protocols. Illustrate by an example.

(b) Byte-oriented protocols. Illustrate by an example.

(c) Framing with Flags. Illustrate by an example.

(d) Clock-based framing. Illustrate by an example.

7. Consider a two-dimensional parity check. 10 Points

   How does it work. Show an example. (illustrate)

8. Briefly explain the following Media Access Control (MAC) protocols with an example. 2.5 Points each

   (a) Random access MAC protocols.

   (b) Reservation-based MAC protocols.

   (c) Slotted Aloha MAC protocols.

   (d) p-persistent. MAC protocols.

9. Station A needs to send a message consisting of 13 packets to station B using a sliding window (window size 3) and go-back-n error control strategy. All packets are ready and immediately available for transmission. If every 5^{th} packet that A transmits gets lost (but no ACKs from B ever get lost), then what is the number of packets that A will transmit for sending the message to B?

10 Points

10. Host A wants to send 20 frames to Host B. the hosts agreed to go with SR ARQ. How many numbers of frames are transmitted by Host A if every 5^{th} frame that is transmitted by Host A is either corrupted or lost? Also compare the number of transmissions of SR ARQ with Go-Back-3 ARQ.

10 Points