Name: _____ PID: _____

UCSD email: _____

For the multiple choice questions, please fill in the circle for the correct answer. For the free-response questions, please write clearly and ensure that your answer fits in the box provided.

Turn in a physical copy at the beginning of class on 04/19 in class.

True or False (12 points)

1. (2 points) Internet Protocol (IP) packets can be sent over a wide variety of network link technologies, including wired link types (e.g., Ethernet), wireless link types (e.g., WiFi), and avian link types (e.g., carrier pidgin). **Answer : True**

   ○ True

   ○ False

2. (2 points) The transport layer ensures that the information transmitted by an application on one host is received properly (i.e., in order and with all correct bits) by an application on another host. **Answer : False**

   ○ True

   ○ False

3. (2 points) New applications (e.g., an online social network for sharing cat videos) can be deployed on existing Internet-connected devices because there is a standardized interface to the underlying layers that make it possible for hosts to communicate with each other across the Internet. **Answer : True**

   ○ True

   ○ False

4. (2 points) The latest network links (e.g., fiber-optic links) are so reliable that we do not need to perform error detection or correction on them like we used to have to do on older noisy links (e.g., copper wire links). **Answer : False**

   ○ True

   ○ False

5. (2 points) The errors that can be detected with a Cyclic Remainder Check (CRC) are a strict superset of the errors that checksums can detect. **Answer : False**

   ○ True

   ○ False

6. (2 points) After transmitting a packet, a sender can learn that the receiver may not have properly got it (and therefore the sender should retransmit it) because the sender experiences a timeout while waiting for an acknowledgement packet from the receiver. **Answer : True**

   ○ True

   ○ False

Error Detection and Correction (20 points)

In this problem you will help you learn how correcting codes work by designing your own code:

(a) (2 points) What should the hamming distance of your codewords be if you want to be able to detect any two bit errors and correct one?

Answer : 3

(b) (8 points) With the hamming distance you derived for the previous question, generate the most efficient set of five bit codewords as possible (the set that can encode as many data bits as possible).

Answer : 00000 00111 11011 11100

(c) (4 points) List all of the invalid five bit sequences that can be corrected, and what codeword they correspond to.

Answer :

Codeword	Sequences
00000	00001 00010 00100 01000 10000
00111	00110 00101 00011 01111 10111
11011	11010 11001 11111 10011 01011
11100	11101 11110 11000 10100 01100

(d) (6 points) How many data bits can your code represent? What is the efficiency of your code? Explain why the efficiency is as high or low as it is.

Answer : Five codewords can only encode two bits, so 40 efficient. Not efficient because of wasted codewords that can not encode any combination because they are not equal distant from the others.

Framing (10 points)

7. (8 points) As an expert in computer networking you are called in by law enforcement to interpret a capture of the transmissions over a wire that an agent is collecting from an ancient network link. This link is similar to HDLC in that it indicates the beginning of a frame with a sentinel bit pattern of `01111110` and it uses bit stuffing to avoid sending the sentinel in the message. What are the individual messages that are being sent on this link (both in binary and ASCII forms)?

```
0111 1110 0101 0011 0110 1000 0110 1111 0111 0101 0110 1100 0110 0100 0010 0000
0111 0111 0110 0101 0010 0000 0111 0010 0110 1111 0110 0010 0010 0000 0111 0100
0110 1000 0110 0101 0010 0000 0110 0010 0110 0001 0110 1110 0110 1011 0011 1110
1011 1111 0010 0010 0011 0111 1011 0111 0001 0011 1011 1010 0010 1011 1011 0000
1011 0100 1011 1010 0000
```

Answer :
0101 0011 0110 1000 0110 1111 0111 0101 0110 1100 0110 0100 0010 0000 0111 0111 0110 0101 0010
0000 0111 0010 0110 1111 0110 0010 0010 0000 0111 0100 0110 1000 0110 0101 0010 0000 0110 0010
0110 0001 0110 1110 0110 1011 0011 1111

Should we rob the bank?
0100 0100 0110 1111 0110 1110 0010 0111 0111 0100 0101 0111 0110 0001 0110 1001 0111 0100 000
Don'tWait

8. (2 points) Are there any errors in the frame? How do you know?

Answer : No. There no occurences of bit pattern 01111111.

Automatic Repeat Request (ARQ) (10 points)

9. (10 points) A TCP sender incurs two losses on the network while sending its first flight of five packets. It will in total send 10 packets. Fill in the progression of new data packets, ACKs, and retransmissions that follows in the diagram below. Assume the sender has a window size of 5 and the receiver has a window size of 3, and the sender is using "fast retransmission" activated by the first duplicate ACK. If you make any other assumptions about the sender or receiver, please write them down.