Midterm Computer Networks X_400487

Please read the following information carefully!

- This exam consists of 10 multiple-choice questions. Each question is worth 300 points.
- You have **60 minutes** to complete this exam.
- Before you hand in your answers, check that your multiple-choice form contains your name and student number, also filled in using the boxes.
- Opening this exam before you are instructed to start is **strictly prohibited**.
- The use of the book, notes, calculators, smartwatches and other aids is **strictly prohibited**.
- Tip: mark your answers on this exam **first**, and only after you are certain of your answers, copy them to the multiple-choice answer form.

1. For each of the statements below, indicate if it is true or false.

   (I) Compared to the traditional phone system, The ARPANET was *more* fault tolerant.

   (II) One of the reasons the OSI model and its protocols did not become popular was that their implementations were bad.

   A. (I) false. (II) false.

   B. (I) false. (II) true.

   C. (I) true. (II) false.

   D. (I) true. (II) true.

Solution: The phone system used physical connections. If one breaks, your connection drops, and a large part of the network may be disconnected. If a link went down in the ARPANET, a new route was configured automatically.

The main reasons the OSI model and its protocols did not catch on are bad timing, bad technology, *bad implementations*, and bad politics.

2. Bruce lives in an old mansion without cable ducts. He wants to have internet access throughout his mansion, without retroactively installing these ducts and cables. He tried installing wireless access points, but the scale of the mansion, and the thickness of the walls, limits their coverage. He proposes to solve the problem by using a team of trained bats. Each bat will be equipped with a small backpack that can fit a 4 terabyte USB flash-drive.

   Assume that there is no overhead, that there are 25 bats in total, and that they fly back and forth at an average speed of 8 meters per second.

   What is the maximum data-rate of this channel when transferring data over a distance of 200 meters?

   A. 1 TB/s

   B. 2 TB/s

   C. 8 TB/s

   D. 16 TB/s

Solution:

$$\frac{4\,\text{TB} \times 25\,\text{bats}}{25\,\text{s} \times 2\,\text{way}} = \frac{100\,\text{TB}}{50\,\text{s}} = \frac{100}{50} = 2\,\text{TB/s}$$

3. Consider a noiseless channel that is 16 MHz wide and uses 8 discrete levels. What is the maximum data rate of this channel?

   A. 96 Mbit/s

   B. 128 Mbit/s

   C. 256 Mbit/s

   D. None of the above.

Solution: $B = 16\,\text{MHz}$. $V = 8$. Noiseless, so Nyquist, which means: $R = 2B \times \log_2(V) \rightarrow R = 2 \times 16000000 \times 3 = 96000000 = 96\,\text{Mb/s}$.

4. Consider the following combinations of stations and chip sequences:

```
Station A: (-1, 1,-1, 1,-1,-1, 1, 1)
Station B: (-1,-1, 1, 1, X, 1, 1,-1)
Station C: ( 1,-1,-1, 1, Y,-1, 1,-1)
```

What should be the value of X and Y to enable successful communication using Code Division Multiplexing?

A. $X = -1, Y = -1$

B. $X = -1, Y = 1$

C. $X = 1, Y = -1$

D. $X = 1, Y = 1$

Solution: All three sequences need to be pairwise orthogonal. A is the same as B in 3 places, so X must be the same as the bit in A, thus -1 (4 the same, 4 different). A is the same as C is 4 places, so Y must be different as the bit in A, thus 1 (4 the same, 4 different).

5. Consider a wireless access point that communicates 4 bits per symbol.

Which of the constellations shown in Figure 1 could the access point be using?

A. *None* of the constellation diagrams.

B. Only the constellation in Figure 1a.

C. Only the constellation in Figure 1b.

D. *Both* of the constellation diagrams.

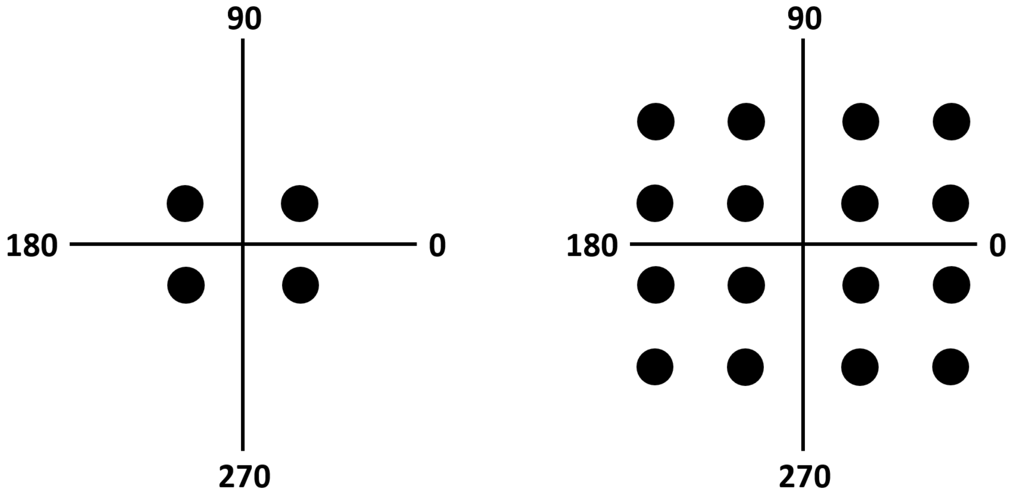
Solution: Figure 1a indicates a constellation with four symbols, which means that it can send at most 2 bits per symbol, so it cannot be this constellation. Figure 1b indicates a constellation with 16 symbols, which means that it can send at most 4 bits per symbol, which matches what we know of the access point. So it could only be Figure 1b.

6. Consider the following messages and generator polynomials.

1. Message: `100 1101 0100`. Generator: `11011`.
2. Message: `111 0001 0101`. Generator: `10101`.

The spaces are added for improved readability.

What are the correct Cyclic Redundancy Check bits for the two message and generator pairs?



(a) (b)

Figure 1

A. 1. 10110
   2. 10101

B. 1. 11001
   2. 00011

C. **1.** 0111
   2. 0111

D. 1. 1110
   2. 1001

Solution: Message and generator 1:

```
100110101000000
11011
 10000101000000
 11011
  1011101000000
  11011
   110001000000
   11011
      111000000
      11011
```

```
        1110000
        11011
          11100
          11011
           0111
```

Message and generator 2:

```
111000101010000
10101
 10010101010000
 10101
   111101010000
   10101
    10111010000
    10101
       10010000
       10101
         111000
         10101
          10010
          10101
           0111
```

7. You receive the codeword 001 1001 1111. You know that the code word includes a Hamming code for error correction, and that the check bits are computed for **even** parity. Bit positions increase from left to right. The spaces are added for improved readability.

   Assume that the codeword either arrives correctly or contains a single-bit error.

   Does received codeword contain an error? If so, what is the corrected codeword?

   A. The code contains an error. The corrected codeword is 001 1011 1111.

   B. The code contains an error. The corrected codeword is 001 1101 1111.

   C. The code contains an error. The corrected codeword is 001 1001 0111.

   D. The codeword does *not* contain an error.

Solution:

```
00110011111
x x x x x x -> 4 % 2 = 0
 xx  xx  xx -> 4 % 2 = 0
   xxxx     -> 2 % 2 = 0
       xxxx -> 4 % 2 = 0
```

The error syndrome is 0, so there in *no* error detected.

8. Consider a data-link layer protocol that uses byte-stuffing. This protocol consists of a single, variable length, payload field.

   Assume that this protocol is used over an unreliable channel that occasionally changes bytes into *flag bytes*.

   Which of the approaches below *cannot* be used by the sender to let the receiver detect (most of) these errors?

   A. Adding a checksum to the end of every message.

   B. Adding a Cyclic Redundancy Check (CRC) to the end of every message.

   C. Adding escape bytes within every message.

   D. Adding the frame-length to the start of every message.

Solution: Frames will sometimes end prematurely because the channel changed one or multiple bytes into flag bytes. This cannot be prevented with escaping, because that happens before the message is sent over the channel. The other solutions work because it allows the receiver to check either the length or the correctness of the received packet, both of which are affected by the erroneous flag byte.

The exam continues on the next page.

9. You are competing with other machines to send data over a shared channel. Although you know how much time it takes to send a frame, and how long each contention slot is, you do not know if you will *ever* get to send your data over the shared channel.

   Which protocol are you using?

   A. Token-ring.

   B. Basic bitmap.

   C. Binary countdown.

   D. Basic bitmap or binary countdown, but you cannot know which.

Solution: Of these four options, only binary countdown gives priority to lower-numbered stations. This brings with it a risk of starvation.

10. Match the correct term to each of the images shown in Figure 2.

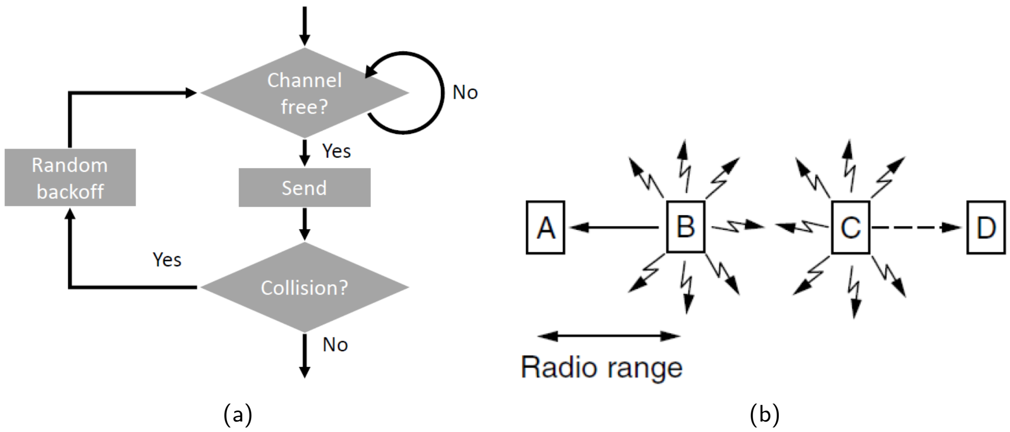


Figure 2

   A. Figure 2a: 1-persistent CSMA. Figure 2b: Exposed terminals.

   B. Figure 2a: 1-persistent CSMA. Figure 2b: Hidden terminals.

   C. Figure 2a: Nonpersistent CSMA. Figure 2b: Exposed terminals.

   D. Figure 2a: Nonpersistent CSMA. Figure 2b: Hidden terminals.

Solution: Once the channel becomes free, it immediately sends, so 1-persistent. The senders hear each other, and therefore think they cannot send to their recipients. This is the *exposed* terminal problem.

End of exam