Question 1 – Error-Correcting Codes

Given:

In this example we consider the “Sudoku code” in a standard form:
Information is arranged in order, in a matrix of size ($n^2 \times n^2$), and encoded into a matrix of size ($n \times n$).
For (n = 3), this is the standard Sudoku. For each row, each column, and each sub-grid (box) we will add a parity bit that is calculated by the bits in it’s associated segment.

What is the minimal distance of this code? Explain why every number of bit errors lower than it is detectable, and give an example showing that the bound is tight.

Question 2 – CRC

Given the following bit string: **1011010110101**, and the polynomial: $G(x)=x^5+x^2+1$.

1. Compute the codeword representation that the sender will transmit.

2. Suppose that during transmission an error occurs at the 4th bit from the left.
   Will the error be detected? Explain why by showing the computation.

Question 3 – Aloha

A network is given with 3 types of Aloha stations:

A red station, which transmits every third time slot.

6 green stations, each of which transmits a frame every in every time slot with $p=\frac{1}{4}$.

Many blue stations, where the number of blue stations transmitting in a time slot is an exponential random time based on a geometric distribution (starting from 0) with
($p=\frac{1}{5}$), meaning:

0 stations transmit: $p=\frac{1}{5}$,

1 stations transmit: $p=\frac{4}{5^2}$,

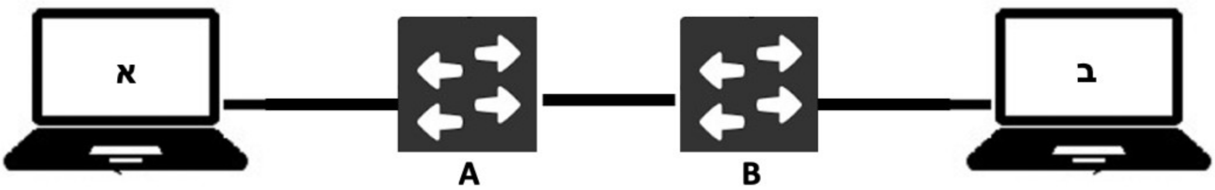
2 stations transmit: $p=\frac{4^2}{5^3}$,

1. Assume the time slots are synchronized (slotted). What is the probability that a randomly chosen time slot contains a successful transmission?

2. Assume blue stations are unsynchronized with the red and green stations, but are synchronized between themselves. Reg and green stations remain synchronized..
   What is the probability that a green frame is successfully transmitted in a randomly chosen time slot?

Question 4 – CSMA/CD

A network is composed of 4 components: Computers א and ב, connected through Ethernet with 2 switches in the middle, as pictured below:



Computer א sends frames of fixed length 800 bits to computer ב.
The network data rate is 100 Mbps.
The physical propagation speed is 100,000 km/s.

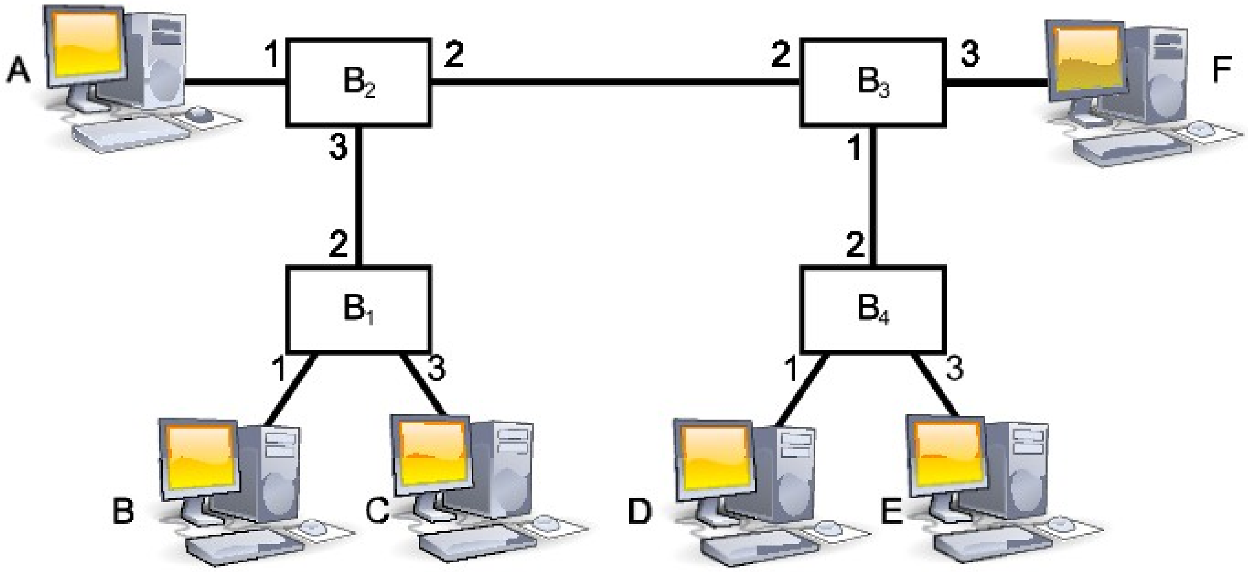
1. All components use CSMA/CD. What is the **maximum permissible distance** between two components? Explain.

2. Now assume the actual distance between the two components is 500 meters.
   Given that segments are quiet before transmission, and adapters start transmitting once they finish receiving it fully, how much time will pass from the moment א begins transmitting until computer ב finishes receiving the frame in full?

3. If computer ב and switch B attempt to transmit to each other, what is the probability that they both fail three times consecutively due to collisions?

Question 5 – Switching / Forwarding Tables

The network shown connects computers by switches. The forwarding tables of the switches begin empty.



1. Assume we first send a message from **A to E**, and then from **B to A**.
   Show the forwarding tables of all switches after the transmissions (include port numbers and MAC addresses).

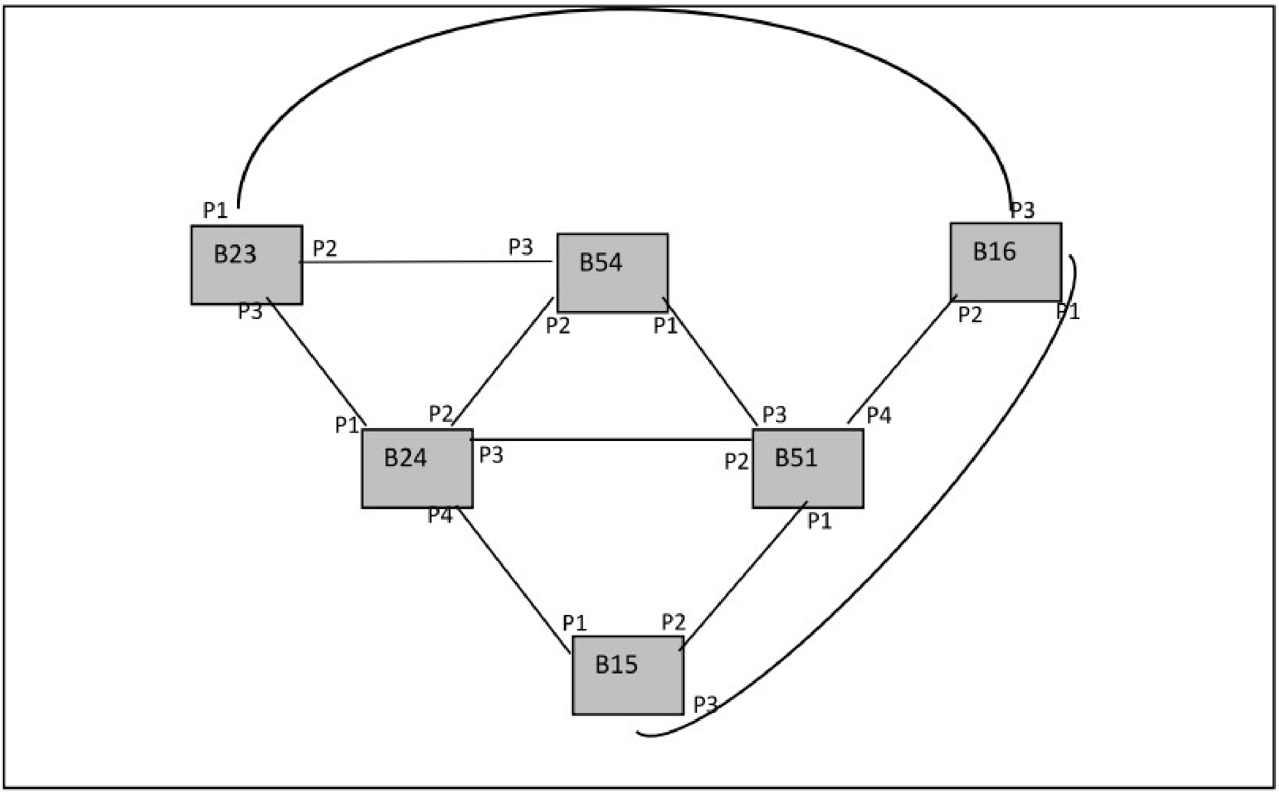
2. Assume switch A is disconnected from port 1 of B_2, and then immediately connected to port 4 of B_3. Afterward, A sends a message to E.

Assume each entry in the table has a TTL that does *not* expire (i.e., no entry is automatically deleted).
From which computers messages directed to A will be received successfully at their destination? Explain.

Question 6 – Spanning Tree Protocol (STP)

The figure shows a local network.

Square marked with B_i indicates a bridge with id *i*. A port of a bridge is marked P_j.



Assume that the algorithm for computing the spanning tree has already stabilized.
Indicate for each bridge its **root-path distance** from the root bridge, and identify its **root port**.