Written examination in Computer Networks

February 20th 2024

Last name: _____

First name: _____

Student number: _____

Mit dem Bearbeiten dieser schriftlichen Prüfung (Klausur) bestätigen Sie, dass Sie diese alleine bearbeiten und dass Sie sich gesund und prüfungsfähig fühlen. Mit dem Erhalt der Aufgabenstellung gilt die Klausur als angetreten und wird bewertet.

By attending this written exam, you confirm that you are working on it alone and feel healthy and capable to participate. Once you have received the examination paper, you are considered to have participated in the exam, and it will be graded.

- Use the provided sheets. Do *not* use own paper.
- You are allowed to use a *self prepared*, *single sided DIN-A4 sheet* in the exam. Only *hand-written originals* are allowed, but no copies.
- You are allowed to use a non-programmable calculator.
- Do *not* use a red pen.
- Time limit: *90 minutes*
- Turn off your mobile phones!

Grade: _____

Questions:	1	2	3	4	5	6	7	8	9	10	11	**Σ**
Maximum Points:	10	5	7	7	8	8	9	8	10	14	4	90
Achieved Points:												

1.0: 90.0-85.5, **1.3**: 85.0-81.0, **1.7**: 80.5-76.5, **2.0**: 76.0-72.0, **2.3**: 71.5-67.5,
2.7: 67.0-63.0, **3.0**: 62.5-58.5, **3.3**: 58.0-54.0, **3.7**: 53.5-49.5, **4.0**: 49.0-45.0, **5.0**: <45

Question 1)

Points: ..... of 10

1 Point (1) Name <u>two</u> systems, that operate according to the simplex principle.

1 Point (2) Name <u>two</u> systems, that operate according to the full-duplex principle.

1 Point (3) Name <u>two</u> systems, that operate according to the half-duplex principle.

5 Points (4) A file with a size of $15 * 10^7$ bits must be transferred from terminal device A to terminal device B. The signal propagation speed is 200,000 km/s. A and B are directly connected by a link with a length of 20,000 km. The file is transferred as a single message, that has a size of $15 * 10^7$ bits. No network protocol headers or trailers exist.

Calculate the transfer time (latency) of the file, when the data rate of the computer network between both terminal devices is 50 Mbps.

2 Points (5) Calculate the bandwidth-delay product for subtask (4) to find out what is the maximum number of bits, that can reside inside the line between the sender and receiver.

Hint: Only the propagation delay is relevant here! *Transmission delay = 0 s* *Waiting time = 0 s.*

Propagation delay = 0.1 s

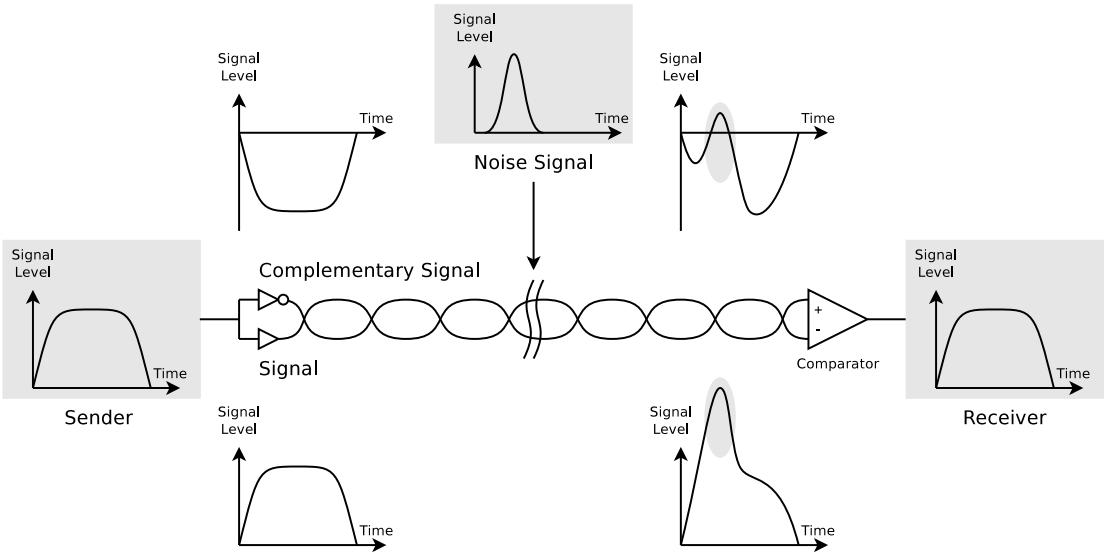
Question 2)

Points: ..... of 5

1 Point (1) Explain why the outer conductor (the shield) of coaxial cables is kept at ground potential and does completely surround the inner conductor.

1 Point (2) Explain why is it impossible to connect different buildings with shielded cables.

3 Points (3) Explain the technique and the effect that this figure demonstrates.



Question 3)

Points: ..... of 7

½ Point (1) Name the hybrid reference model layer that specifies signals.

½ Point (2) Name the hybrid reference model layer that specifies segments.

½ Point (3) Name the hybrid reference model layer that specifies packets.

½ Point (4) Name the hybrid reference model layer that specifies frames.

1 Point (5) Explain what the purpose of Repeaters in computer networks is.

1 Point (6) Name and explain the network topology(s) that Hubs implement.

1 Point (7) Explain what a collision domain is.

1 Point (8) Explain why computer networks require line codes.

1 Point (9) Explain the way Non-Return-To-Zero (NRZ) works.

Question 4)

Points: ..... of 7

1 Point (1) Name the two problems that can occur when NRZ is used to encode data.

2 Points (2) Explain both problems from subtask (1) in detail.

2 Points (3) Explain how the problems from subtask (1) can be avoided.

1 Point (4) Explain what the purpose of Bridges in computer networks is.

1 Point (5) Explain why Bridges and Layer-2-Switches do not require physical or logical addresses.

Question 5)

Points: ..... of 8

½ Point (1) Name <u>one</u> example of a Bridge implementation.

1 Point (2) Name the information that is stored in the forwarding tables of Bridges.

1 Point (3) Explain what a Designated Bridge is and what its task is.

1 Point (4) Give the number of Designated Bridges, a computer network contains.

1 Point (5) Give the selection criteria for determining, whether a Bridge becomes a Designated Bridge.

1½ Points (6) Name <u>three</u> devices that split the collision domain

½ Point (7) Name <u>one</u> device that splits the broadcast domain

½ Point (8) Name the protocol that is used for translating Network Layer addresses into Data Link Layer addresses.

1 Point (9) Explain the purpose of Routers in computer networks.
(*Also explain the difference to Layer-3-Switches.*)

Question 6)

Points: ..... of 8

4 Points

(1) Error detection via CRC: Calculate the frame to be transferred.

```
Generator polynomial: 100101
Payload: 11010011
```

3 Points

(2) Error detection via CRC: Check if the received frame was transmitted correctly.

```
Transferred frame: 1011010110110
Generator polynomial: 100101
```

1 Point

(3) Explain why up-to-date Data Link Layer protocols, such as Ethernet and WLAN, only provide error detection but no error correction method.

Question 7)

Points: ..... of 9

1 Point (1) One way to mark the frames' borders is via character count in the frame header. Name a potential issue that can arise from this method.

1 Point (2) One way to mark the frames' borders is via Byte Stuffing. Name a drawback of this method.

1 Point (3) Explain why up-to-date Data Link Layer protocols, such as Ethernet and WLAN, work bit-oriented and not byte-oriented.

1 Point (4) Explain why Gateways in the Network Layer of computer networks are seldom required nowadays.

½ Point (5) Explain the meaning of Unicast in the Network Layer.

½ Point (6) Explain the meaning of Broadcast in the Network Layer.

½ Point (7) Explain the meaning of Anycast in the Network Layer.

½ Point (8) Explain the meaning of Multicast in the Network Layer.

1 Point (9) Name <u>one</u> private IPv4 address space.

2 Points (10) Describe in simple words the functioning of CIDR.
(*Focus on the way, how IP addresses are treated and subnets are created.*)

Question 8)

Points: ..... of 8

4 Points (1) Calculate the first and last host addresses, the network address and the broadcast address of the subnet.

```
IP Address:          151.175.30.100    10010111.10101111.00011110.01100100

Subnet mask:         255.255.240.0     11111111.11111111.11110000.00000000

Network address?     ___.___.___.___   ________.________.________.________

First host address?  ___.___.___.___   ________.________.________.________

Last host address?   ___.___.___.___   ________.________.________.________

Broadcast address?   ___.___.___.___   ________.________.________.________
```

binary representation	decimal representation	binary representation	decimal representation
10000000	128	11111000	248
11000000	192	11111100	252
11100000	224	11111110	254
11110000	240	11111111	255

½ Point (2) Give the class of the IP address in subtask (1).

½ Point (3) Give the number of bits for host IDs in subtask (1).

½ Point (4) Give the number of host IDs per subnet in subtask (1).

½ Point (5) Give the number of bits for subnet IDs in subtask (1).

½ Point (6) Give the number of possible subnets in subtask (1).

½ Point (7) Give the name of the scope of IPv6 addresses that have the prefix `fe80::/10`.

½ Point (8) Give the name of the scope of IPv6 addresses that have the prefix `fc00::/7`.

½ Point (9) Give the name of the scope of IPv6 addresses that have the prefix `2000::/3`.

Question 9)

Points: ..... of 10

1 Point (1) Explain what the Host Scope is in IPv6.

1 Point (2) Explain what the Link-Local Scope is in IPv6.

1 Point (3) Explain what the Unique-Local Scope is in IPv6.

1 Point (4) Explain what the Global Scope is in IPv6.

1 Point (5) IPv6 has no broadcast addresses but for some purposes, a broadcast-like functionality is required. Explain how IPv6 emulates the broadcast functionality.

1 Point (6) Give the prefix of Multicast addresses in IPv6.

3 Points (7) Name three ways of setting the Interface-ID in IPv6.

1 Point (8) Explain why IPv6 requires Duplicate Address Detection (DAD).

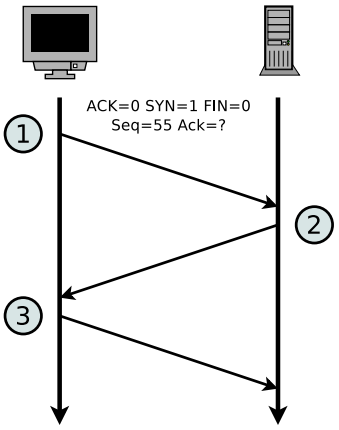
Question 10)

Points: ..... of 14

4 Points

(1) The diagram shows the establishment of a TCP connection. Complete the table.

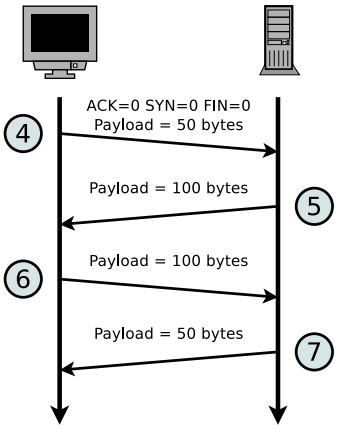
Message	ACK flag	SYN flag	FIN flag	Payload length	Seq number	Ack number
1					55	
2					20	
3						



5 Points

(2) The diagram shows an excerpt of the transmission phase of a TCP connection. Complete the table.

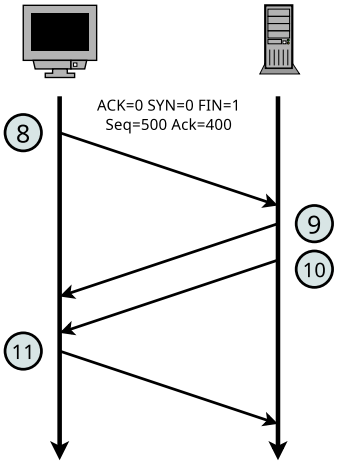
Message	ACK flag	SYN flag	FIN flag	Payload length	Seq number	Ack number
4				50	200	300
5				100		
6						
7						



5 Points

(3) The diagram shows the termination of a TCP connection. Complete the table.

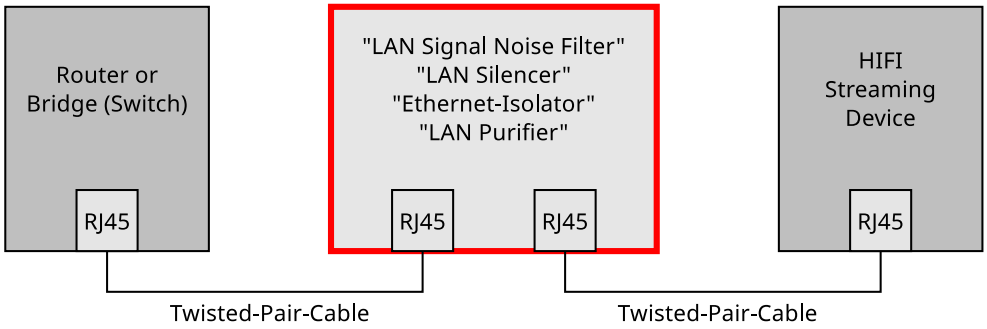
Message	ACK flag	SYN flag	FIN flag	Payload length	Seq number	Ack number
8			1	0	500	400
9						
10						
11						



Question 11)

Points: ..... of 4

Some vendors sell so-called „LAN Signal Noise Filters“ (sometimes called „Ethernet Filter“, „LAN Silencer“, „LAN Purifier“, or „Ethernet-Isolator“) that are supposed to remove Electrical interference (noise signals) from Ethernet connections (twisted-pair cables with RJ45 connectors) between a Router/Switch and a streaming device, aiming to improve the music quality in HIFI applications. The figure demonstrates the concept of using such a device.



1 Point (1) Has such a device the potential to improve the music quality?

☐ yes ☐ no ☐ maybe

3 Points (2) Explain your opinion on the effectiveness in detail.