Written examination in Computer Networks

March 3rd 2021

Last name: _____

First name: _____

Student number: _____

Mit dem Bearbeiten dieser schriftlichen Prüfung (Klausur) bestätigen Sie das Sie diese alleine bearbeiten und das 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 *handwritten 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!

Result:

Question:	1	2	3	4	5	6	7	8	9	**Σ**	Grade
Maximum points:	8	6	8	8	7	14	14	11	14	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

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Question 1)

Points: .....

Maximum points: 3+3+1+1=8

a) An image has a size of 4096x2160 pixels (Ultra HD 4K) with true color (3 Bytes per pixel are used for the color information). How long does it take to transmit the uncompressed image via a 50 Mbps ($= 50 * 10^6$ Bits per second) DSL connection?

b) Name the topology that is used by ...

modern Ethernet standards	
Thin Ethernet and Thick Ethernet	
WLAN without an Access Point	
WLAN with an Access Point	
Powerline Communication (PowerLAN)	
mobile phones (GSM standard)	

c) Name <u>one</u> topology...

where a cable failure causes the entire network to fail	
that has no central component (device)	

d) Mark the label of Twisted Pair Cables that have no cable and no pair shielding.

☐ *ATP* ☐ *FTP* ☐ *STP* ☐ *UTP* ☐ *XTP* ☐ *ZTP*

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Question 2)

Points: .....

Maximum points: 6

A webcam at the surface of (dwarf) planet Pluto sends pictures to Earth. Each image has a size of 15 MB (1 MB = 2^{20} Byte). Calculate the time needed to transfer a picture to Mission Control on Earth.

(Note: The network connection is a point-to-point link.)

Data rate = 1 kbps (kilobit per second) $= 1 * 10^3$ *bit per second*
Signal propagation speed = 299,792,458 m/s
Waiting time = 0 s
Distance = 6,000,000,000,000 m $= 6 * 10^{12}$ *m*

(Note: At its most distant, when Earth and Pluto are on the opposite sides of the sun from one another, Pluto lies 7.5 billion kilometers from Earth. At their closest, Pluto and Earth are only 4.28 billion km apart. For the further calculations – just to keep it simple – we use 6 billion km = 6,000,000,000 km.)

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Question 3)

Points: .....

Maximum points: 0.5+1+1+1+1+1+2.5=8

a) Data Link Layer protocols specify the format of...

☐ physical network addresses ☐ logical network addresses

b) Give the name (technical term) of Data Link Layer addresses.

c) Name the protocol that is used by Ethernet for the address resolution.

d) Explain what MAC spoofing is.

e) 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.

f) Why do up-to-date Data Link Layer protocols, such as Ethernet and WLAN, work bit-oriented and not byte-oriented?

g) Mark the information that an Ethernet frame contains.

☐ Sender and receiver MAC addresses
☐ Hostname of the sender and receiver
☐ Information about the Transport Layer protocol used
☐ Preamble to synchronize the receiver
☐ Port number of the receiver
☐ CRC checksum
☐ Information about the Application Layer protocol used
☐ Mojo level
☐ VLAN tag
☐ Sender and receiver IP addresses
☐ Information about the Network Layer protocol used
☐ Signals, which are transmitted via the transmission medium
☐ Port number of the sender

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Question 4)

Points: .....

Maximum points: 4+4=8

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

```
Generator polynomial: 100101
Payload: 101010
```

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

```
Transferred frame: 1101001110100
Generator polynomial: 100101
```

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Question 5)

Points: .....

Maximum points: 3+4=7

a) Error Correction via simplified Hamming Distance (Hamming ECC method). Calculate the message that will be transmitted (payload inclusive parity bits).

`Payload: 01001100`

b) Error Correction via simplified Hamming Distance (Hamming ECC method). Verify if the received message was transmitted correctly.

`Received message: 001101100100`

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Question 6)

Points: .....

Maximum points: 2+1+1+5+5=14

a) Which devices subdivide (spilt) the collision domain (do not forward collisions)?

☐ Repeater ☐ Layer-3-Switch ☐ Router
☐ Layer-2-Switch ☐ Hub ☐ Bridge

b) Which devices subdivide (spilt) the broadcast domain (do not forward broadcasts)?

☐ Layer-3-Switch ☐ Layer-2-Switch ☐ Repeater
☐ Hub ☐ Bridge ☐ Router

c) Name <u>one</u> private IPv4 address space.

d) Split the class B network `135.129.222.0` for implementing 10 subnets. Calculate the subnet masks and answer the questions.

```
Network ID:     10000111.10000001.11011110.00000000    135.129.222.0
Number of bits for subnet IDs?
Subnet mask:    ________.________.________.________     ___.___.___.___
Number of bits for host IDs?
Number of host IDs per subnet?
```

e) Split the class C network `195.3.128.0` into subnets which contain 60 hosts each. Calculate the subnet masks and answer the questions.

```
Network ID:     11000011.00000011.10000000.00000000    195.3.128.0
Number of bits for host IDs?
Number of bits for subnet IDs?
Number of possible subnets?
Subnet mask:    ________.________.________.________     ___.___.___.___
```

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

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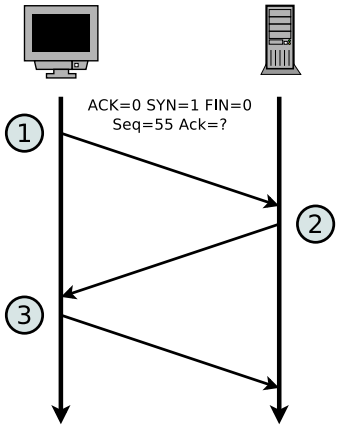
Question 7)

Points: .....

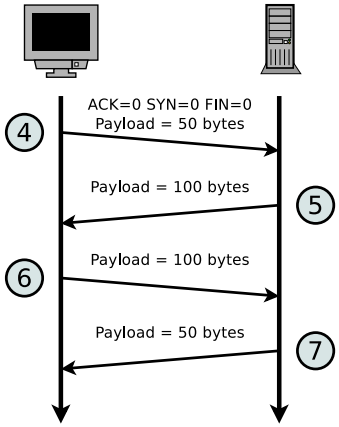
Maximum points: 4+5+5=14

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



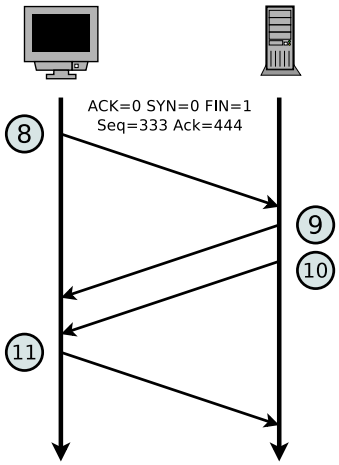
Message	ACK flag	SYN flag	FIN flag	Payload length	Seq number	Ack number
1					55	
2					20	
3						

b) 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	100	200
5				100		
6						
7						

c) 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	333	444
9						
10						
11						

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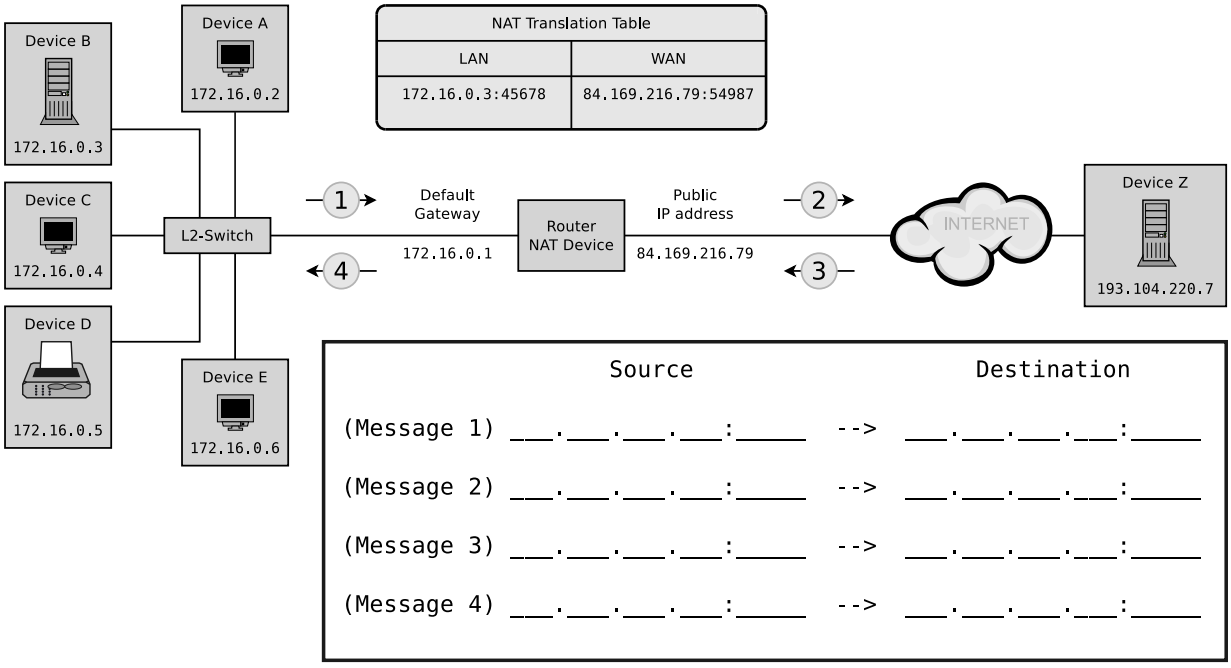
Question 8)

Points: .....

Maximum points: 8+3=11

a) Fill the missing IP addresses and port numbers into the figure that describes a NAT scenario where device B sends a request for an email to an email server process that runs on device Z and can be accessed on device Z via port number 110.



b) The sender transmits an IP packet to a receiver. Calculate the subnet ID of sender and receiver and specify whether the IP packet leaves the subnet during transmission or not.

```
Sender:        10000100.10011000.01010011.11111110    132.152.83.254
Subnet mask:   11111111.11111111.11111100.00000000    255.255.252.0


Receiver:      10000100.10011000.01010001.00000010    132.152.81.2
Subnet mask:   11111111.11111111.11111100.00000000    255.255.252.0
```

```
Subnet ID of sender?
Subnet ID of receiver?
Does the IP packet leave the subnet [yes/no]?
```

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Question 9)

Points: .....

Maximum points: 14

For the network devices, protocols, transmission units, line codes and addressing schemes in the table, mark the corresponding layer of the hybrid reference model.

(1 stands for bottom layer and 5 for top layer in the hybrid reference model. If more than just a single layer are a correct answer, it is sufficient to select at least one correct layer.)

	Hybrid reference model layer				
	1	2	3	4	5
Congestion control					
CSMA/CA, CSMA/CD					
Distance vector routing protocol					
Dynamic Host Configuration Protocol (DHCP)					
Flow control					
Frame					
Hub					
Hypertext Transfer Protocol (HTTP)					
ICMP					
Internet Protocol (IP)					
Link state routing protocol					
Logical address					
Manchester-Code					
Media access control					
Network Time Protocol (NTP)					
Non-Return to Zero (NRZ)					
Open Shortest Path First (OSPF)					
Packet					
Physical address					
Port number					
Reliable end-to-end (process-to-process) connection					
Repeater					
Signal					
Spanning Tree Protocol (STP)					
Transmission Control Protocol (TCP)					
Transmission Media					
Non-Return to Zero Invert (NRZI)					
User Datagram Protocol (UDP)					