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First name:

Student number:

Question 1)

Points:

Maximum points: $4+0,5+0,5+1+0,5+0,5=7$

- a) A scientific experiment produces 35 petabytes ($35 * 2^{50}$ Byte) of data per year, which need to be stored. What is the height of a stack of storage media, if for storing the data CDs (capacity: $650 \text{ MB} = 650 * 10^6$ Byte, thickness: 1.2 mm) are used?
- Calculate the solution for $35 \text{ PB} = 35 * 2^{50}$ Byte

 - Calculate the solution for $35 \text{ PB} = 35 * 10^{15}$ Byte
- b) Name an advantage of serial data transmission compared with parallel data transmission.
- c) Name an advantage of parallel data transmission compared with serial data transmission.
- d) Do computer networks usually implement parallel or serial data transmission?
- e) What describes the physical topology of a computer network?
- f) What describes the logical topology of a computer network?

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Question 2)

Points:

Maximum points: 4

A scientific experiment produces 30 petabytes ($30 * 2^{50}$ Byte) of data per year. How much time requires the transmission of the data via an Ethernet with a bandwidth of 1 gigabit per second?

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Question 3)

Points:

Maximum points: 6

A webcam at the surface of planet Mars sends pictures to Earth. Each image has a size of 30 MB (1 MB = 2^{20} Byte). How quickly, after a picture is taken, can it reach Mission Control on Earth?

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

Data rate = 256 kbps (kilobit per second)

Signal propagation speed = 299.792.458 m/s

Waiting time = 0 s

Distance = 55.000.000.000 m

(Note: The distance between Earth and Mars fluctuates between approx. 55,000,000 km and approx. 400,000,000 km. For the further calculations, we use the 55,000,000 km, which is the distance from Earth to Mars, when they are closest together.)

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Question 4)

Points:

Maximum points: 12+1+1=14

a) Fill out all empty fields.

(Please fill in each empty cell only one correct answer!)

ISO/OSI Reference Model

Layer	Protocol	Device	Sort of Data (data unit)	Addresses
7				
6				
5				
4				
3				
2				
1				

b) Mark the IP address of the Default Gateway in the output of route -n.

```
# route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
0.0.0.0 192.168.0.1 0.0.0.0 UG 1024 0 0 eth0
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0
```

c) Mark the MAC address of the Default Gateway in the output of arp -n.

```
# arp -n
192.168.0.191 ether 00:11:32:1c:03:f3 C eth0
192.168.0.21 ether 1c:b0:94:c4:a2:74 C eth0
192.168.0.1 ether 08:96:d7:2a:c6:06 C eth0
```

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Question 5)

Points:

Maximum points: $1+2+2+2=7$

- a) Why is it impossible to connect different buildings with shielded cables?
- b) Name a benefit and a drawback of mono-mode (single-mode) fibers compared with multi-mode fibers.
- c) Name a benefit and a drawback of multi-mode fibers compared mono-mode (single-mode) fibers.
- d) The following information come from existing twisted pair network cables. What information is provided about the shielding of these cables?
- E138922 RU AWM 2835 24 AWG 60°C CSA LL81295 FT2 ETL VERIFIED
EIA/TIA-568A CAT.5 UTP EVERNEW G3C511
 - E188601 (UL) TYPE CM 75°C LL84201 CSA TYPE CMG FT4 CAT.5E PATCH
CABLE TO TIA/EIA 568A STP 26AWG STRANDED
 - SSTP ENHANCED CAT.5 350MHZ 26AWG X 4P PATCH TYPE CM (UL) C(UL)
E200579 CMG CSA LL81924 3P VERIFIED
 - EC-net 7.5 m 11184406 13/03 PremiumNet 4 PAIR 26AWG S-FTP HF IEC
332-1 ENHANCED CATEGORY 5 PATCH CORD EN0173+ISO/IEC

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Question 7)

Points:

Maximum points: $1+2+2+1+1=7$

- a) Describe the functioning of the line code Non-Return-To-Zero (NRZ)?

- b) What two problems can occur, when NRZ is used to encode data?

- c) How can the problems from subtask b) be avoided?

- d) Why is it important for the receiver of signals, which are encoded according to the Differential Manchester Encoding, to know the initial signal level?

- e) Why do some line codes, that map groups of payload bits onto groups of code bits, implement variants with neutral inequality, positive inequality and negative inequality?

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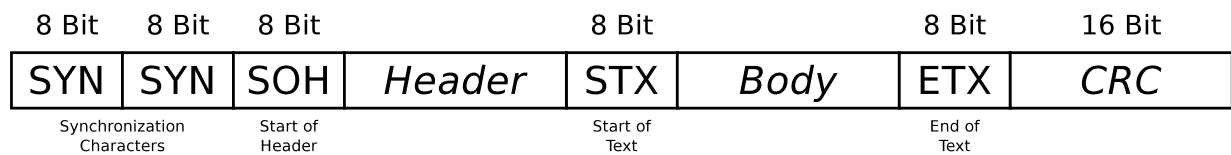
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Question 9)

Points:

Maximum points: 2+2+2+2=8

The character-oriented protocol BISYNC uses control characters to mark the structure of the frames. The start of a frame highlights the character SYN. The start of the header highlights the character SOH (*Start of header*). The payload is located between STX (*Start of text*) and ETX (*End of text*).



If the payload (body) contains the control characters ETX and DLE (*Data Link Escape*), they are protected (*escaped*) by the Data Link Layer protocol with a stuffed DLE character. A single ETX in the payload area is represented by the sequence DLE ETX. The DLE character itself is represented by the sequence DLE DLE.

Control character	SOH	STX	ETX	DLE	SYN
Hexadecimal notation	01	02	03	10	16

Mark the payload inside the following BISYNC frames?

- a) 16 16 01 99 98 97 96 95 02 C1 12 34 56 78 90 C2 03 A0 B7
- b) 16 16 01 99 98 97 96 95 02 B1 10 10 10 10 10 10 10 10 10 10 B3 03 76 35
- c) 16 16 01 99 98 97 96 95 02 10 03 10 10 10 03 10 10 10 03 10 10 03 92 55
- d) 16 16 01 99 98 97 96 95 02 10 10 A1 10 10 B1 10 03 C1 01 C2 A1 03 99 B2

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Question 10)

Points:

Maximum points: 4+4=8

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

Generator polynomial: 100101

Payload: 10110101

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

Transferred frame: 1010010110100

Generator polynomial: 100101

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Question 11)

Points:

Maximum points: 5+3=8

- a) Split the class A network 16.0.0.0 for implementing 513 subnets. Calculate the subnet masks and answer the questions.

Network ID: 00010000.00000000.00000000.00000000 16.0.0.0

Number of bits for subnet IDs?

Subnet mask: -----.-----.-----.----- ---.---.---.---

Number of bits for host IDs?

Number of host IDs per subnet?

- 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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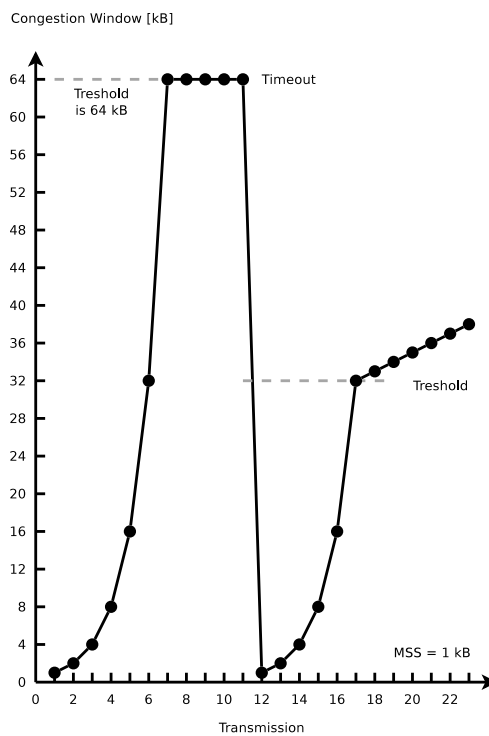
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Question 13)

Points:

Maximum points: 2+1+1=4

a) Mark in the figure the slow-start phase and the congestion avoidance phase both.



b) Describe what fast retransmit is?

c) Describe what fast recovery is?