Sample solution of the written examination in

Computer Networks

May 16th 2014

Last name: _____

First name: _____

Student number: _____

I confirm with my signature that I will process the written examination alone
and that I feel healthy and capable to participate this examination.
I am aware, that from the moment, when I receive the written examination, I
am a participant of this examination and I will be graded.

Signature: _____

- Provide on all sheets (including the cover sheet) your *last name*, *first name* and *student number*.

- Use the provided sheets. Own paper must *not* be used.

- Place your *ID card* and your *student ID card* on your table.

- 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.

- Answers, written with pencil or red pen are *not* accepted.

- The time limit ist *90 minutes*.

- Turn off your mobile phones!

Result:

Question:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Σ	Grade
Maximum points:	6	6	4	10	11	7	5	6	5	8	4	7	4	7	90	—
Achieved points:																

Question 1)   Points: . . . .
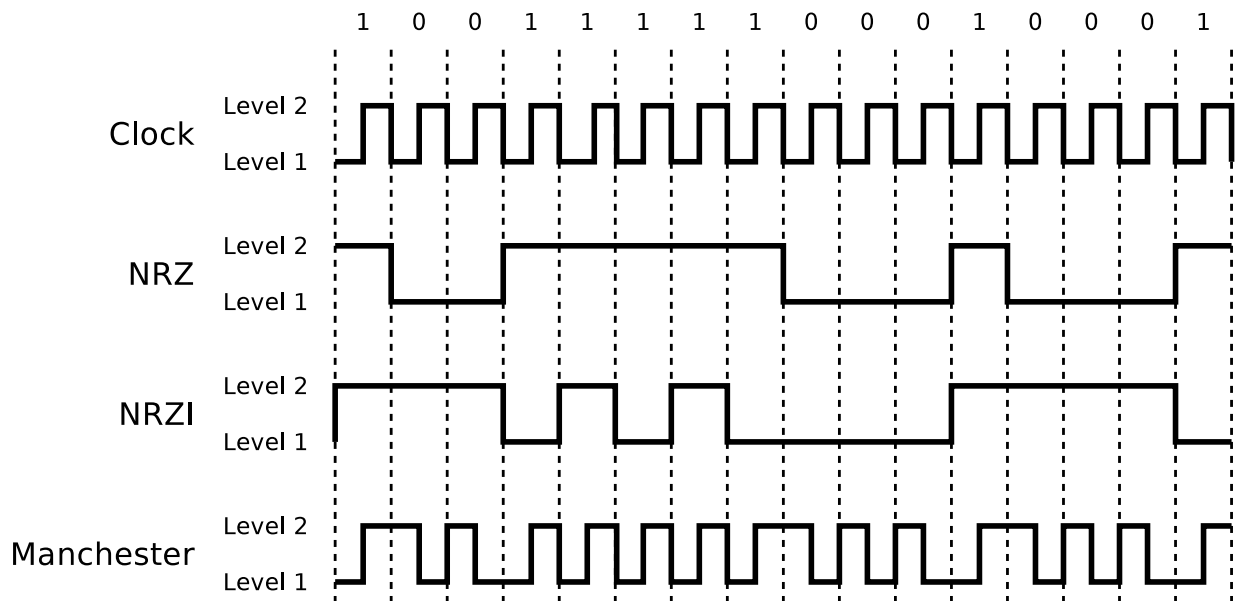
Maximum points: 6

Give the encoding for the given bit pattern.

Please assume that the initial signal level of NRZI is signal level 1 (low signal).

Question 2)

Points: . . . .

Maximum points: 0.5+0.5+1+1+1+1+1=6

a) Explain the difference between serial data transmission and parallel data transmission.

Parallel data transmission: In addition to the control lines multiple data lines exists.

Serial data transmission: In addition to the control lines, only a single exists. The bits are transmitted one after another via the bus.

b) Computer networks usually implement. . .

☒ serial data transmission   □ parallel data transmission

c) Name an advantage of serial data transmission.

Fewer wires are required.

d) Name an advantage of parallel data transmission.

Higher throughput.

e) Name 2 systems, that operate according to the simplex principle.

Radio, TV, pager, satellite broadcast, GPS, radio clock signal.

f) Name 2 systems, that operate according to the full-duplex principle.

Ethernet via twisted pair cables.

Telephone.

g) Name 2 systems, that operate according to the half-duplex principle.

Networks with fiber-optic cables with mono-mode (single-mode) fibers.

Networks with coaxial cables, because there exists just a single line to sending and receiving.

Wireless networks with just a single channel.

Walkie-talkies with just a single channel.

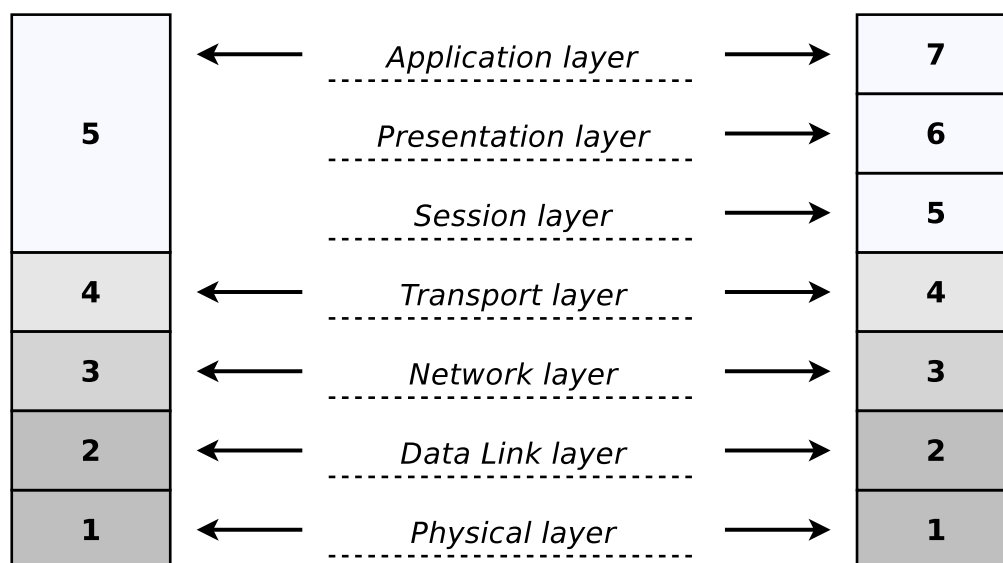# Question 3)   Points: ....

Maximum points: 3.5+0.5=4

a) Write on the dotted lines the names of the layers.

Hybrid Reference Model   **OSI Reference Model**

5	← *Application layer* →	**7**
	Presentation layer →	**6**
	Session layer →	**5**
4	← *Transport layer* →	**4**
3	← *Network layer* →	**3**
2	← *Data Link layer* →	**2**
1	← *Physical layer* →	**1**

b) Why are the layers 5 and 6 of the OSI reference model not intensively used in practice?

The functionalities, which are intended for the Session Layer and Presentation Layer, are now part of protocols and services in the Application Layer.

Question 4)

Points: . . . .

Maximum points: 10

Mark for each row of the table the corresponding layer of the **hybrid reference model**.

1 stands for the bottom layer and 5 for the 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 a single correct layer.

	Hybrid reference model layer				
	1	2	3	4	5
4B5B	X				
Address Resolution Protocol (ARP)		X			
Alternate Mark Inversion (AMI)	X				
Autonomous Systems			X		
Border Gateway Protocol (BGP)			X		
Bridge	X	X			
Congestion control				X	
CSMA/CA		X			
CSMA/CD		X			
Cyclic Redundancy Check (CRC)		X			
Distance vector routing protocols			X		
Dynamic Host Configuration Protocol (DHCP)					X
Ethernet	X	X			
File Transfer Protocol (FTP)					X
Flow control				X	
Gateway	X	X	X	X	X
Hub	X	X			
Hypertext Transfer Protocol (HTTP)					X
ICMP			X		
Internet Protocol (IP)			X		

Last name: First name: Student number:

Question 5)   Points: . . . .

Maximum points: 11

Mark for each row of the table the corresponding layer of the **hybrid reference model**.

1 stands for the bottom layer and 5 for the 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 a single correct layer.

	Hybrid reference model layer				
	1	2	3	4	5
Link state routing protocols			X		
Logical addresses			X		
Manchester-Code	X				
Media access control		X			
Modem	X	X			
Multilevel Transmission Encoding - 3 Levels	X				
Multiport Bridge	X	X			
Non-Return to Zero	X				
Open Shortest Path First (OSPF)			X		
Physical addresses		X			
Port numbers				X	
Reliable end-to-end data connection				X	
Repeater	X				
Router	X	X	X		
Routing Information Protocol (RIP)	X		X		
Security					X
Spanning Tree Protocol (STP)		X			
Switch	X	X	X		
Telnet					X
Transmission Control Protocol (TCP)				X	
User Datagram Protocol (UDP)				X	
Wireless LAN	X	X			

Question 6)

Maximum points: 1+1+1+1+1+1+1=7

a) What is the major difference between Bridges and Layer-2-Switches?

Bridges with > 2 ports are called Multiport Bridge or Layer-2-Switch.

b) Why do Bridges and Layer-2-Switches not require physical or logical addresses?

Bridges do not need addresses for filtering and forwarding the frames, because they do not actively participate in the communication. They work transparent, just like the devices of the Physical Layer.

c) What is the advantage of learning Bridges in contrast to „dumb" Bridges?

Learning Bridges learn which network devices are accessible via which port.

d) What happens, if for a network device no entry exists in the forwarding table of a Bridge?

This is not a problem because the table is only used for optimization. If for a network device no entry in the forwarding table exists, the Bridge forwards the frame in every case.

e) What is a switched network?

In a switched network, each port of the switches is connected with just a single network device.

f) Name an advantage of a switched network.

Such a network is free from collisions and state of the art.

g) Why is it impossible to connect different buildings with shielded cables?

Shields must be electrically grounded on both sides of the cable. If only one end of a shielded cable is grounded, an antenna effect occurs, which results in a compensation current.

Question 7)

Maximum points: 1+1+1+1+1=5

a) What is the task of the Root Bridge?

   The Root Bridge always forwards frames via all its ports.

b) What is the selection criteria for determining, whether a Bridge becomes the Root Bridge?

   First, the Bridges have to determine the Bridge with the lowest Bridge Priority in the Bridge ID. This Bridge is the Root Bridge of the spanning tree to be generated.

c) What is a Designated Bridge and what is its task?

   For each physical network, a single one of the directly connected Bridges needs to be selected as responsible for forwarding the frames towards in the direction of the Root Bridge. This Bridge is called Designated Bridge for this network.

d) How many Designated Bridges does a computer network contain?

   For each physical network, a single Designated Bridge exists.

e) What is the selection criteria for determining, whether a Bridge becomes a Designated Bridge?

   The Bridge with the lowest path costs to the Root Bridge is selected as Designated Bridge.

Question 8)

Maximum points: 1+1+1+3=6

a) 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.

   If the field, which contains the number of bytes payload inside the frame is modified during transmission, the receiver is unable to correctly detect the end of the frame.

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

   The strong relationship with the ASCII character encoding.

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

   Because this allows using any character encoding.

d) What information contains an Ethernet frame?

   ☐ Sender IP address
   ☒ Sender MAC address
   ☐ Hostname of the 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
   ☒ VLAN tag
   ☒ Receiver MAC address
   ☐ Receiver IP address
   ☒ Information about the Network Layer protocol used
   ☐ Hostname of the sender
   ☐ Signals, which are transmitted via the transmission medium
   ☐ Port number of the sender

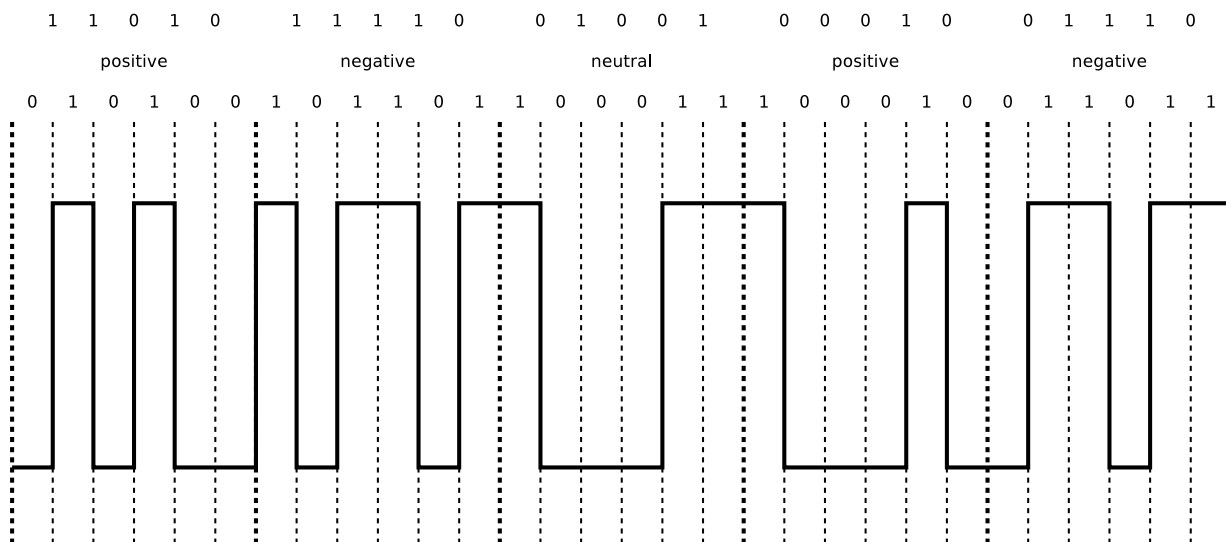Last name: First name: Student number:

Question 9)

Points: . . . .

Maximum points: 5

Encode the bit sequence with 5B6B and NRZ and draw the signal curve.

Bit sequence: 11010 11110 01001 00010 01110

```
1  1  0  1  0    1  1  1  1  0    0  1  0  0  1    0  0  0  1  0    0  1  1  1  0
    positive          negative          neutral           positive         negative
0 1 0 1 0 0 1 0 1 1 0 1 1 0 0 0 1 1 1 0 0 0 1 0 0 1 1 0 1 1
```

| 5B	6B neutral	6B positive	6B negative	5B	6B neutral	6B positive	6B negative
00000		001100	110011	10000		000101	111010
00001	101100			10001	100101		
00010		100010	101110	10010		001001	110110
00011	001101			10011	010110		
00100		001010	110101	10100	111000		
00101	010101			10101		011000	100111
00110	001110			10110	011001		
00111	001011			10111		100001	011110
01000	000111			11000	110001		
01001	100011			11001	101010		
01010	100110			11010		010100	101011
01011		000110	111001	11011	110100		
01100		101000	010111	11100	011100		
01101	011010			11101	010011		
01110		100100	011011	11110		010010	101101
01111	101001			11111	110010		

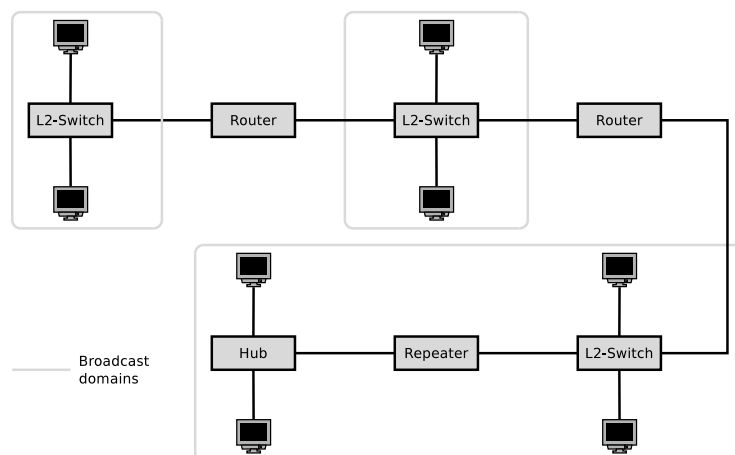# Question 10)   Points: ....

Maximum points: 5.5+1.5+1=8

a) Sketch in the diagram of the network topology all collision domains.
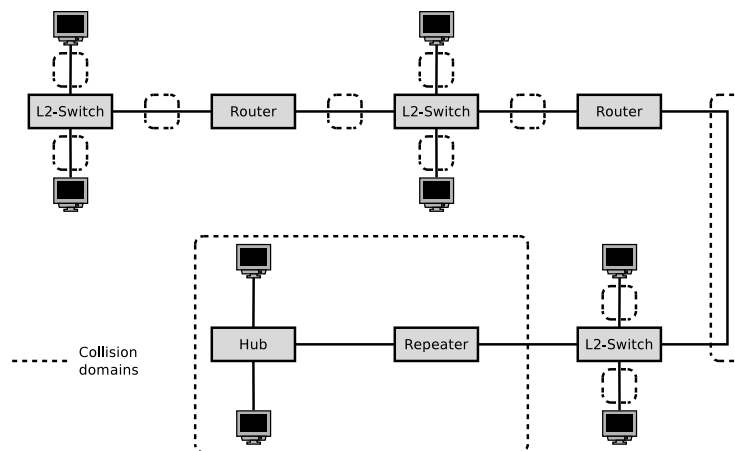
b) Sketch in the diagram of the network topology all broadcast domains.

c) How many logical subnets are required for this network topology?

   Three logical subnets are required.

Question 11)

Maximum points: 4

Error Detection via CRC: Check, if the received frame was transmitted correctly.

Received frame: 1101001111100   Generator polynomial: 100101

```
1101001111100
100101|||||||
------v|||||||
 100011||||||
 100101||||||
 ------vvv|||
    110111|||
    100101|||
    ------v||
     100101||
     100101||
     ------vv
           00 => Transmission was error-free
```

Question 12)

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: 10011010

Step 1: Determine parity bit positions:

```
            Position:  1  2  3  4  5  6  7  8  9 10 11 12
Data to be transmitted:  ?  ?  1  ?  0  0  1  ?  1  0  1  0
```

Step 2: Calculate parity bit values:

```
        0011 Position 3
        0111 Position 7
        1001 Position 9
    XOR 1011 Position 11
    --------------------
        0110 = parity bit values
```

Step 3: Insert parity bit values into the transmission:

```
            Position:  1  2  3  4  5  6  7  8  9 10 11 12
Data to be transmitted:  0  1  1  1  0  0  1  0  1  0  1  0
```

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

    Received message: 0001101100101101

```
Received data: 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16
               0  0  0  1  1  0  1  1  0  0  1  0  1  1  0  1

        00101 Position 5
        00111 Position 7
        01011 Position 11
        01101 Position 13
    XOR 01110 Position 14
    --------------------
        01010 Parity bits calculated
    XOR 00111 Parity bits received
    --------------------
        01101 => Bit 13 ist defective!
```

Question 13)

Points: . . . .

Maximum points: 4

Calculate the first and last host addresses, the network address and the broadcast address of the subnet.

```
IP Address:         151.175.31.100    10010111.10101111.00011111.01100100

Subnet mask:        255.255.255.128   11111111.11111111.11111111.10000000

Network address?    151.175.31.0      10010111.10101111.00011111.00000000

First host address? 151.175.31.1      10010111.10101111.00011111.00000001

Last host address?  151.175.31.126    10010111.10101111.00011111.01111110

Broadcast address?  151.175.31.127    10010111.10101111.00011111.01111111
```

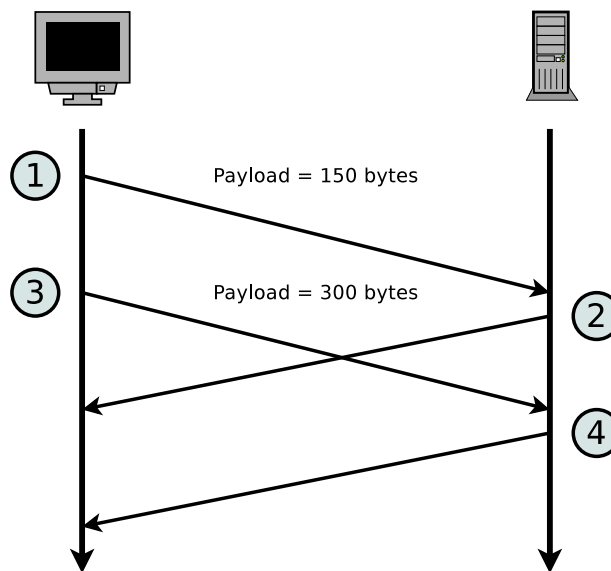| binary representation	decimal representation
10000000	128
11000000	192
11100000	224
11110000	240
11111000	248
11111100	252
11111110	254
11111111	255

Question 14)

Points: ....

Maximum points: 7

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

Message	ACK	SYN	FIN	Payload length	Seq number	Ack number
1	0	0	0	150	831	1251
2	1	0	0	0	1251	981
3	0	0	0	300	981	1251
4	1	0	0	0	1251	1281