

Written examination in Computer Networks

February 24th 2017

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.
- Time limit: *90 minutes*
- Turn off your mobile phones!

Result:

[illegible]

Last name:

First name:

Student number:

Question 1)

Points:

Maximum points: 11

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 | SMTP | | Message | |
| 6 | | | | |
| 5 | | | | |
| 4 | | | | |
| 3 | | | | |
| 2 | | | | |
| 1 | | | | |

Last name:

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Question 2)

Points:

Maximum points: 3

a) 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
- E324441 RU AWM 2835 24AWG 60°C 30V CHANGJIANG TIA/EIA 568B.2 UTP
CAT.5e
- 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
- (UL) E228252 TYPE CM 75°C 24AWG 4PR UTP C(UL) E228252 CMR 73°C ETL
VERIFIED TIA/EIA 568B.2 CAT.5e

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Question 3)

Points:

Maximum points: 4

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

IP Address: 130.120.20.123 10000010.01111000.00010100.01111011

Subnet mask: 255.255.240.0 11111111.11111111.11110000.00000000

Network address? _____.____.____.____ _____._____._____._____

First host address? _____.____.____.____ _____._____._____._____

Last host address? _____.____.____.____ _____._____._____._____

Broadcast address? _____.____.____.____ _____._____._____._____

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

Last name:

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Student number:

Question 4)

Points:

Maximum points: $2.5+2.5=5$

- a) Split the class B network 189.23.0.0 for implementing 20 subnets. Calculate the subnet mask and answer the questions.

Network ID: 10111101.00010111.00000000.00000000 189.23.0.0

Number of bits for subnet IDs?

Subnet mask:

Number of bits for host IDs?

Number of host IDs per subnet?

- b) Split the class B network 129.15.0.0 into subnets, which contain 10 hosts each. Calculate the subnet mask and answer the questions.

Network ID: 10000001.00001111.00000000.00000000 129.15.0.0

Number of bits for host IDs?

Number of bits for subnet IDs?

Number of possible subnets?

Subnet mask:

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

Last name:

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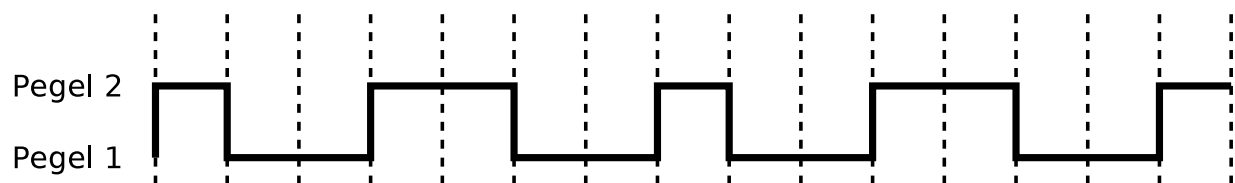
Student number:

Question 5)

Points:

Maximum points: 3

This signal curve is encoded with NRZI and 4B5B. Decode the data.



| Label | 4B | 5B | Function |
|-------|------|-------|---------------|
| 0 | 0000 | 11110 | 0 hexadecimal |
| 1 | 0001 | 01001 | 1 hexadecimal |
| 2 | 0010 | 10100 | 2 hexadecimal |
| 3 | 0011 | 10101 | 3 hexadecimal |
| 4 | 0100 | 01010 | 4 hexadecimal |
| 5 | 0101 | 01011 | 5 hexadecimal |
| 6 | 0110 | 01110 | 6 hexadecimal |
| 7 | 0111 | 01111 | 7 hexadecimal |
| 8 | 1000 | 10010 | 8 hexadecimal |
| 9 | 1001 | 10011 | 9 hexadecimal |
| A | 1010 | 10110 | A hexadecimal |
| B | 1011 | 10111 | B hexadecimal |
| C | 1100 | 11010 | C hexadecimal |
| D | 1101 | 11011 | D hexadecimal |
| E | 1110 | 11100 | E hexadecimal |
| F | 1111 | 11101 | F hexadecimal |

Last name:

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Question 6)

Points:

Maximum points: 5

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

Bit sequence: 11010 11110 01001 00010 01110

.....

| 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 | | |

Last name:

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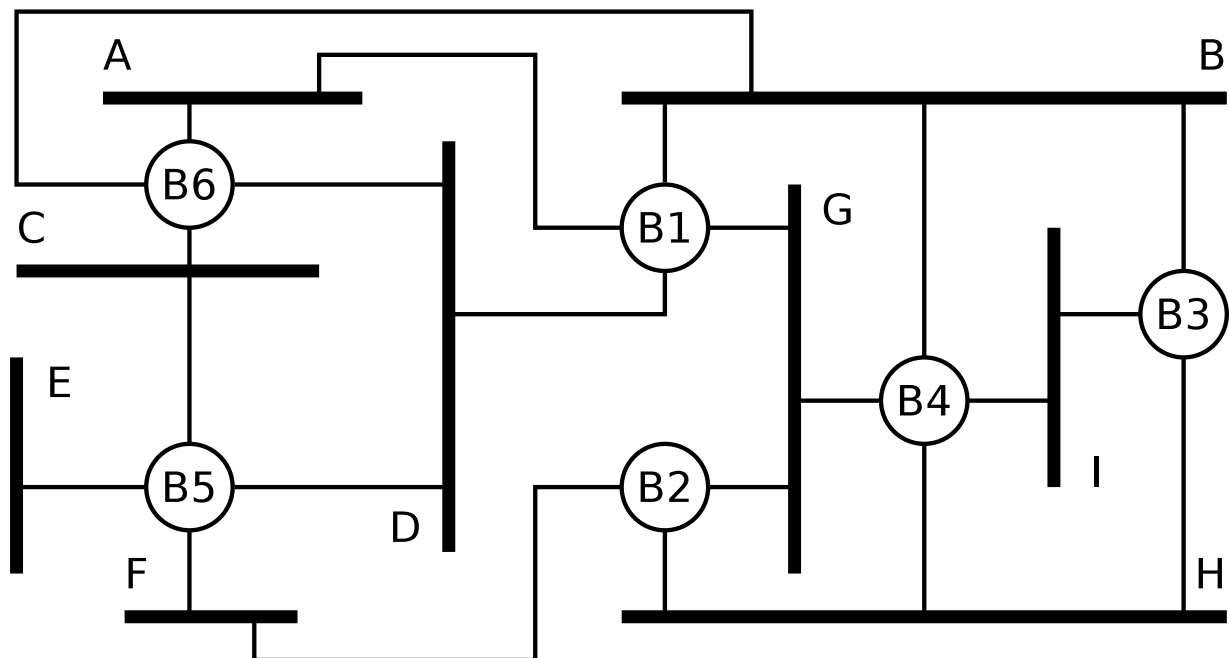
Student number:

Question 7)

Points:

Maximum points: 6

The figure shows the physical connections of a network. All Bridges boot up at the same time after a power failure. Highlight in the figure which ports and Bridges are not used when the Spanning Tree Protocol is used.



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Student number:

Question 8)

Points:

Maximum points: 4+4=8

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

Generator polynomial: 100101

Payload: 11010011

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

Transferred frame: 1011010110100

Generator polynomial: 100101

Last name:

First name:

Student number:

Question 9)

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: 10011010

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

Received message: 0001101100101101

Last name:

First name:

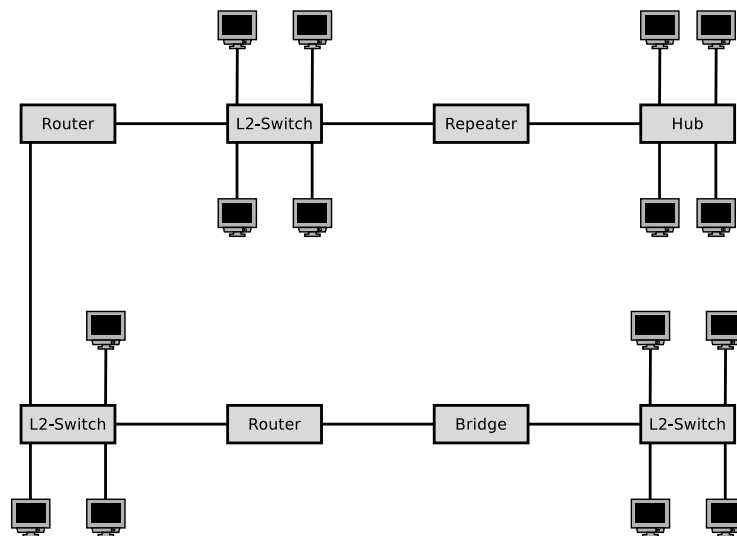
Student number:

Question 10)

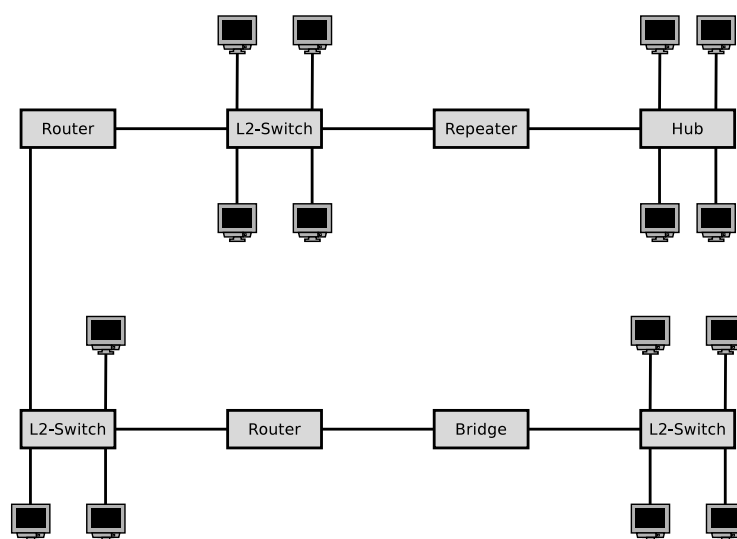
Points:

Maximum points: 10

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



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



Last name:

First name:

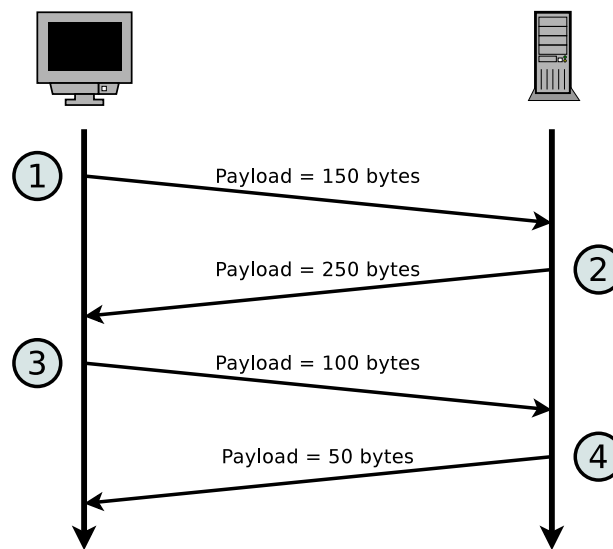
Student number:

Question 11)

Points:

Maximum points: 6

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 | 1800 | 2500 |
| 2 | | 0 | 0 | | | |
| 3 | | 0 | 0 | | | |
| 4 | | 0 | 0 | | | |

Last name:

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Student number:

Question 12)

Points:

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

- a) 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
```

- b) 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
```

- c) The `ifconfig` tool says the local IP address is 192.168.150.71, but the website checkip.dyndns.org says the current IP address is 194.94.82.237. What technology is probably used?

- d) What specifies the Maximum Transmission Unit (MTU)?

- e) Given the following configuration, what will happen if you send UDP segments with length 2500 Bytes via `eth0` from this machine?

```
# ifconfig eth0
eth0    Link encap:Ethernet  HWaddr B8:27:EB:CE:50:E2
        inet addr:10.0.0.9  Bcast:10.0.0.255  Mask:255.255.255.0
        UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
        RX packets:6853190 errors:0 dropped:370 overruns:0 frame:0
        TX packets:3453175 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:1000
        RX bytes:1516614221 (1.4 GiB)  TX bytes:306452639 (292.2 MiB)
```

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Question 13 – Part 1/2) Points:

Maximum points: $4.5+8+1+3.5=17$

Figure 1: Network topology

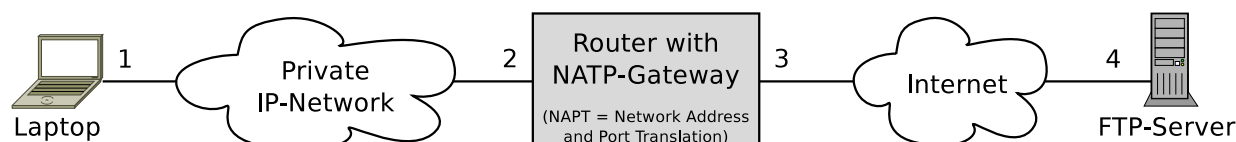


Figure 2: Wireshark output of a received transmission on interface 1

```
Ethernet II, Src: JuniperN_7a:d6:81 (50:c5:8d:7a:d6:81), Dst: ActionSt_0b:2a:ed (00:24:9b:0b:2a:ed)
Internet Protocol Version 4, Src: 217.160.233.106, Dst: 192.168.50.17
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 75
    Identification: 0x1eb4 (7860)
  Flags: 0x00
    Fragment offset: 0
    Time to live: 56
    Protocol: TCP (6)
  Header checksum: 0xae34 [validation disabled]
    Source: 217.160.233.106
    Destination: 192.168.50.17
Transmission Control Protocol, Src Port: 21 (21), Dst Port: 4934 (4934), Seq: 24, Ack: 11, Len: 35
File Transfer Protocol (FTP)
```

Figure 3: Wireshark output of a received transmission on interface 3

```
Ethernet II, Src: 22:ac:11:45:e3:44 (22:ac:11:45:e3:44), Dst: JuniperN_bb:2e:fa (50:c5:8d:bb:2e:fa)
Internet Protocol Version 4, Src: 217.160.233.106, Dst: 194.94.80.16
  0100 .... = Version: 4
  .... 0101 = Header Length: 20 bytes (5)
  Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 75
    Identification: 0x1eb4 (7860)
  Flags: 0x00
    Fragment offset: 0
    Time to live: 56
    Protocol: TCP (6)
  Header checksum: 0xae34 [validation disabled]
    Source: 217.160.233.106
    Destination: 194.94.80.16
Transmission Control Protocol, Src Port: 21 (21), Dst Port: 22345 (22345), Seq: 3306717526, Ack: 1149803236, Len: 35
File Transfer Protocol (FTP)
```

The transmissions in figure 2 and figure 3 correspond with each other because they are used to transport the same FTP data. They transport the reply from the FTP server, which is initiated by a request of the laptop.

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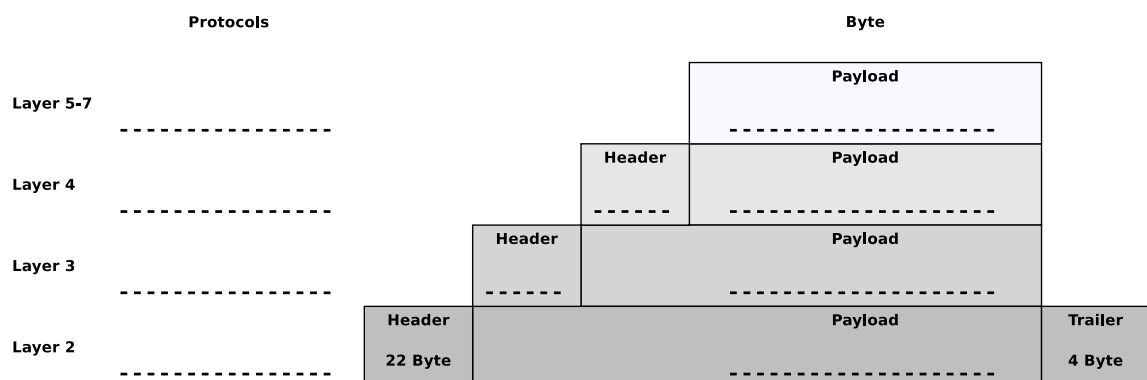
Question 13 – Part 2/2) Points:

Maximum points: $4.5+8+1+3.5=17$

- a) Fill out all empty fields of the table.

| Interface | 1 | 2 | 3 | 4 |
|-------------|---|---|---|---|
| MAC address | | | | |
| IP address | | | | |
| Port number | | | | |

- b) Show the protocol stack (starting with OSI layer 2) of the transmission in Figure 3. Fill in the correct number of Bytes of the headers, trailer and payloads. Also name the protocols used. Consider the FTP data as pure payload.



- c) What is the amount of overhead in Bytes for the transmission of the FTP data (header and payload)?

- d) Calculate the overhead ratio in % (possible OSI layer 1 overhead is ignored).