Exercise Sheet 5

Exercise 1 (IPv4 Addressing in the Network Layer)

Calculate for each subtask of this exercise 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:	255.255.254.0	11111111.11111111.11111110.00000000
Network address?	___.___.___.___	________.________.________.________
First host address?	___.___.___.___	________.________.________.________
Last host address?	___.___.___.___	________.________.________.________
Broadcast address?	___.___.___.___	________.________.________.________
IP Address:	151.175.31.100	10010111.10101111.00011111.01100100
Subnet mask:	255.255.255.240	11111111.11111111.11111111.11110000
Network address?	___.___.___.___	________.________.________.________
First host address?	___.___.___.___	________.________.________.________
Last host address?	___.___.___.___	________.________.________.________
Broadcast address?	___.___.___.___	________.________.________.________
IP Address:	151.175.31.100	10010111.10101111.00011111.01100100
Subnet mask:	255.255.255.128	11111111.11111111.11111111.10000000
Network address?	___.___.___.___	________.________.________.________
First host address?	___.___.___.___	________.________.________.________
Last host address?	___.___.___.___	________.________.________.________
Broadcast address?	___.___.___.___	________.________.________.________

Exercise 2 (Inter-Networking)

1. Calculate for the **subnet ID of sender and receiver** and specify whether the IP packet **leaves the subnet during transmission** or not for the following two examples.

   a)

Sender:	11001001.00010100.11011110.00001101	201.20.222.13
Subnet mask:	11111111.11111111.11111111.11110000	255.255.255.240
Receiver:	11001001.00010100.11011110.00010001	201.20.222.17
Subnet mask:	11111111.11111111.11111111.11110000	255.255.255.240

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

b)
```
Sender:       00001111.11001000.01100011.00010111    15.200.99.23
Subnet mask:  11111111.11000000.00000000.00000000    255.192.0.0

Receiver:     00001111.11101111.00000001.00000001    15.239.1.1
Subnet mask:  11111111.11000000.00000000.00000000    255.192.0.0
```

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

2. The forwarding table of a computer (Windows or Unix) can be queried with the command `netstat -rn`. An exemplary output may look like this:

```
Kernel IP routing table
Destination   Gateway     Genmask          Flags   MSS Window irtt Iface
0.0.0.0       10.2.0.1    0.0.0.0          UG        0 0          0 eth0
10.2.0.0      0.0.0.0     255.255.255.0    U         0 0          0 eth1
10.204.0.0    0.0.0.0     255.252.0.0      U         0 0          0 wlan0
10.200.0.0    0.0.0.0     255.248.0.0      U         0 0          0 eth2
172.17.8.15   0.0.0.0     255.255.255.255  UH        0 0          0 eth2
192.168.23.0  0.0.0.0     255.255.255.0    U         0 0          0 wlan1
192.168.42.0  0.0.0.0     255.255.255.240  U         0 0          0 eth3
```

Specify the particular interface the kernel will choose for each destinations with following IPv4 addresses and explain why:

a) `192.168.23.14`

b) `192.168.42.17`

c) `192.168.42.15`

d) `10.2.0.255`

e) `10.207.51.4`

f) `172.17.8.18`

g) `172.17.8.15`

h) `10.202.4.3`

i) `10.216.168.23`

Exercise 3 (Subnetting)

Calculate for each subtask of this exercise the **subnet masks** and answer the **questions**.

1. Split the class C network `195.1.31.0` for implementing 30 subnets.

```
Network ID:     11000011.00000001.00011111.00000000    195.1.31.0
Number of bits for subnet IDs?
Subnet mask:    ________.________.________.________    ___.___.___.___
Number of bits for host IDs?
Number of host IDs per subnet?
```

2. Split the class A network `15.0.0.0` for implementing 333 subnets.

```
Network ID:     00001111.00000000.00000000.00000000    15.0.0.0
Number of bits for subnet IDs?
Subnet mask:    ________.________.________.________    ___.___.___.___
Number of bits for host IDs?
Number of host IDs per subnet?
```

3. Split the class B network `189.23.0.0` for implementing 20 subnets.

```
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?
```

4. Split the class C network `195.3.128.0` into subnets, which contain 17 hosts each.

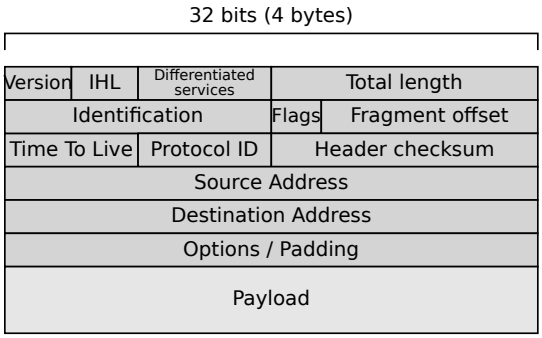
```
Network ID:     11000011.00000011.10000000.00000000    195.3.128.0
Number of bits for host IDs?
Number of bits for subnet IDs?
Number of possible subnets?
Subnet mask:    ________.________.________.________    ___.___.___.___
```

5. Split the class B network `129.15.0.0` into subnets, which contain 10 hosts each.

```
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:    ________.________.________.________    ___.___.___.___
```

Exercise 4 (Checksums in IP Packets)

The figure shows the structure of IPv4 packets as discussed in the computer networks course.



The given data in hexadecimal notation is a truncated excerpt of an IP packet:

```
4500 0034 B612 4000 4006 6F80 0A00 008B 5BC6 AEE0
```

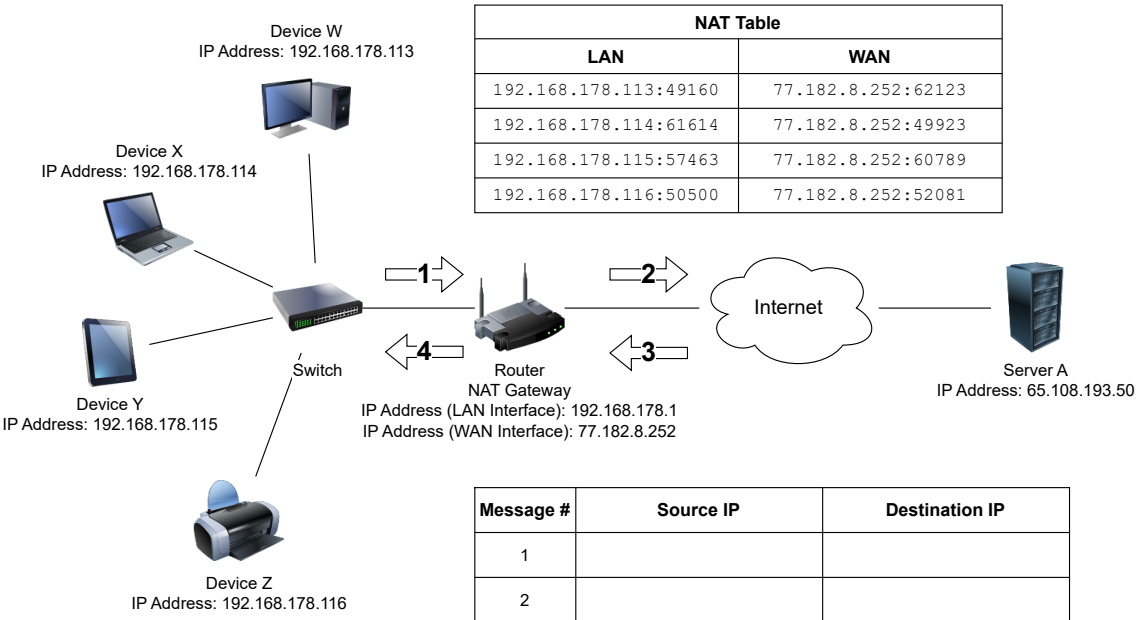
The data contains the values of the fields of the IP packet header.

```
4          = Version
 5         = IHL = IP Header Length (⟹ 5 * 4 Byte words = 20 bytes)
   00      = Differentiated services
0034       = Total length (⟹ 52 bytes)
B612       = Identification
4000       = Flags + Fragment offset
40         = Time To live (⟹ 62 hops)
  06       = Protocol ID (⟹ TCP)
6F80       = Header Checksum
0A00 008B  = IP address (sender)
5BC6 AEE0  = IP address (destination)
```

1. **Calculate** the checksum for each IP header:
   - `4500 0034 4C22 4000 F706 ???? C163 9055 0A00 008B`
   - `4500 0034 671E 4000 4006 ???? 0A00 008b C163 9055`
   - `4500 00F2 0000 4000 4011 ???? 0A00 008b 0A00 00FF`
2. **Verify** the checksum of each IP header:
   - `4500 0034 02FD 4000 3606 276C 6CA0 A330 0A00 008B`
   - `4500 00E7 02FC 4000 3606 37BC 6CA0 A330 0A00 008B`
   - `4500 0034 A9D5 4000 4006 814E 0A00 008B adC2 4613`

Exercise 5 (Network Address Translation)

The figure below describes a NAT scenario. Fill the missing IP addresses and port numbers into the figure when device B sends a request to an web server process that runs on server A that can be accessed at port number 443.



NAT Table	
LAN	**WAN**
192.168.178.113:49160	77.182.8.252:62123
192.168.178.114:61614	77.182.8.252:49923
192.168.178.115:57463	77.182.8.252:60789
192.168.178.116:50500	77.182.8.252:52081

Message #	Source IP	Destination IP
1		
2		
3		
4		

Exercise 6 (Address Types and Spaces)

1. Name the three private IPv4 address spaces.
2. What is the prefix for a link-local address in IPv4 and IPv6 networks?
3. Which of the following IPv4 addresses are multicast addresses?

   ☐ 222.1.2.3

   ☐ 224.1.2.3

   ☐ 242.0.0.0

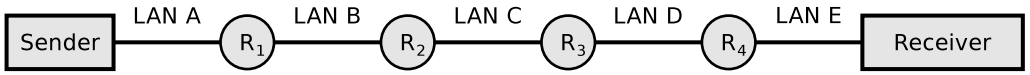
   ☐ 234.23.23.23

4. How can an IPv6 anycast address be distinguished from a unicast or a multicast address?

5. Which IPv6 address can you use in order to *ping* all stations in a local network?
6. What type of address is given with `fd04:2342:0815:1:6770:37ca:7a5c:f408/64`? What is its purpose?
7. What type of address is given with `ff02::1:ff5c:f408`? What is its purpose?

Exercise 7 (Fragmenting IP Packets)

4,000 bytes payload need to be transmitted via the IP protocol. The payload must be fragmented, because it is transmitted over multiple physical networks, whose MTU is $< 4,000$ bytes. Display graphically the way, the payload is fragmented, and how many bytes of payload each fragment contains.



	LAN A	LAN B	LAN C	LAN D	LAN E
Network technology	Ethernet	PPPoE	ISDN	Ethernet	WLAN
MTU [bytes]	1,500	1,492	576	1,400	2,312
IP-Header [bytes]	20	20	20	20	20
maximum payload [bytes]	1,480	1,472	556	1,380	2,292

Display graphically the way, the payload is fragmented, and how many bytes of payload each fragment contains.

Exercise 8 (IPv6 Address Representation)

1. Simplify these IPv6 addresses:
   - `1080:0000:0000:0000:0007:0700:0003:316b`

     Solution: _____
   - `2001:0db8:0000:0000:f065:00ff:0000:03ec`

     Solution: _____
   - `2001:0db8:3c4d:0016:0000:0000:2a3f:2a4d`

     Solution: _____
   - `2001:0c60:f0a1:0000:0000:0000:0000:0001`

     Solution: _____

- `2111:00ab:0000:0004:0000:0000:0000:1234`

  Solution: _____

2. Provide all positions of these simplified IPv6 addresses:

   - `2001::2:0:0:1`

     Solution: `____:____:____:____:____:____:____:____`

   - `2001:db8:0:c::1c`

     Solution: `____:____:____:____:____:____:____:____`

   - `1080::9956:0:0:234`

     Solution: `____:____:____:____:____:____:____:____`

   - `2001:638:208:ef34::91ff:0:5424`

     Solution: `____:____:____:____:____:____:____:____`

   - `2001:0:85a4::4a1e:370:7112`

     Solution: `____:____:____:____:____:____:____:____`

Exercise 9 (Do some research)

1. The transition from IPv4 to IPv6 may indicate that one IP version number has been skipped. What happened to **IPv5**?

2. Explain the meaning of the fields `Flags`, `MSS`, `Window`, and `irtt` in the forwarding table as shown in task 2.

3. In IPv6 different scopes are defined. Figure out which of the originally defined scopes has been declared as deprecated (and why).

4. Describe the purpose of the following address blocks:

   - 192.0.2.0/24
   - 198.51.100.0/24
   - 203.0.113.0/24