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.

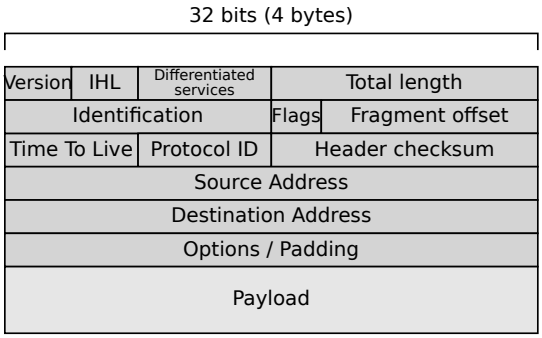
```
Network ID:     11000011.00000011.10000000.00000000    195.3.128.0
Number of bits for host IDs?
Number of bits for subnet IDs?
Number of possible subnets?
Subnet mask:    ________.________.________.________    ___.___.___.___
```

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)
```

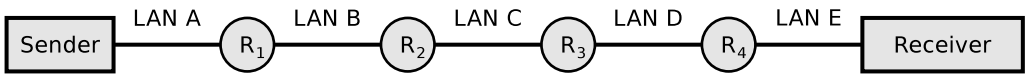
1. **Calculate** the checksum for each IP header:
   - `4500 0034 4C22 4000 F706 ???? C163 9055 0A00 008B`
   - `4500 0034 671E 4000 4006 ???? 0A00 008b C163 9055`
   - `4500 00F2 0000 4000 4011 ???? 0A00 008b 0A00 00FF`
2. **Verify** the checksum of each IP header:
   - `4500 0034 02FD 4000 3606 276C 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 (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 6 (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 7 (Forwarding and Path Calculation)

1. What is an **autonomous system**?
2. Which two major classes for **adaptive, dynamic routing protocols** exist?
3. Which **algorithms** are implemented by each of the routing protocol classes from subtask 2?
4. The **Border Gateway Protocol** (BGP) is a protocol for...

   ☐ Intra-AS routing ☐ Inter-AS routing
5. Which **routing protocol class** from subtask 2 implements the BGP?
6. **Open Shortest Path First** (OSPF) is a protocol for...

   ☐ Intra-AS routing ☐ Inter-AS routing
7. Which **routing protocol class** from subtask 2 implements OSPF?
8. The **Routing Information Protocol** (RIP) is a protocol for...

   ☐ Intra-AS routing ☐ Inter-AS routing
9. Which **routing protocol class** from subtask 2 implements the RIP?
10. When RIP is used, each Router communicates only with its **direct neighbors**. What are the **advantages** and **drawbacks** of method?
11. When RIP is used, the path cost (metric) depend only on the number of Routers (**hops**), which need to be passed on the way to the destination network. What is the **drawback** of this method?
12. When OSPF is used, **all Routers** communicate with each other. What are the **advantages** and **drawbacks** of method?

Exercise 8 (Bellman-Ford Algorithm)

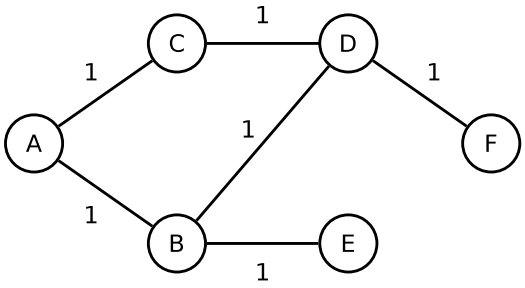
1. **Calculate** the entries of the routing tables for each advertisement round of the Routing Information Protocol (RIP).
   (*The hop metric is used.*)

Step 1

Dest.	Hop	Metric
A	?	∞
B	?	∞
C	C	0
D	?	∞
E	?	∞
F	?	∞

Dest.	Hop	Metric
A	?	∞
B	?	∞
C	?	∞
D	D	0
E	?	∞
F	?	∞

Dest.	Hop	Metric
A	A	0
B	?	∞
C	?	∞
D	?	∞
E	?	∞
F	?	∞

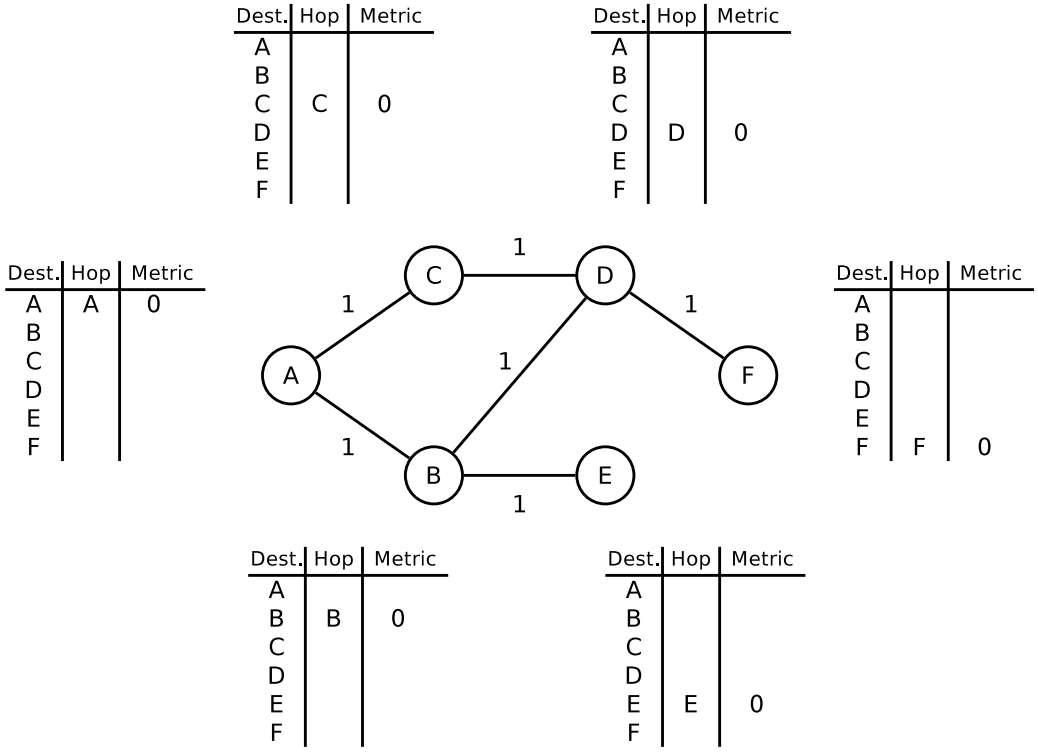


Dest.	Hop	Metric
A	?	∞
B	?	∞
C	?	∞
D	?	∞
E	?	∞
F	F	0

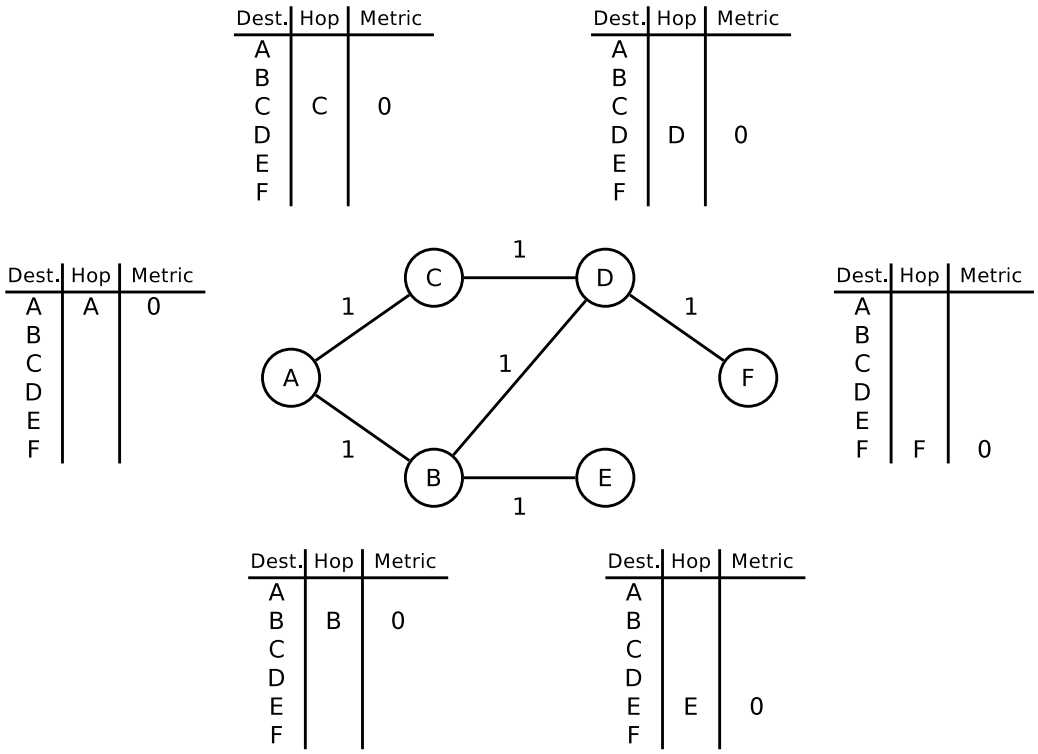
Dest.	Hop	Metric
A	?	∞
B	B	0
C	?	∞
D	?	∞
E	?	∞
F	?	∞

Dest.	Hop	Metric
A	?	∞
B	?	∞
C	?	∞
D	?	∞
E	E	0
F	?	∞

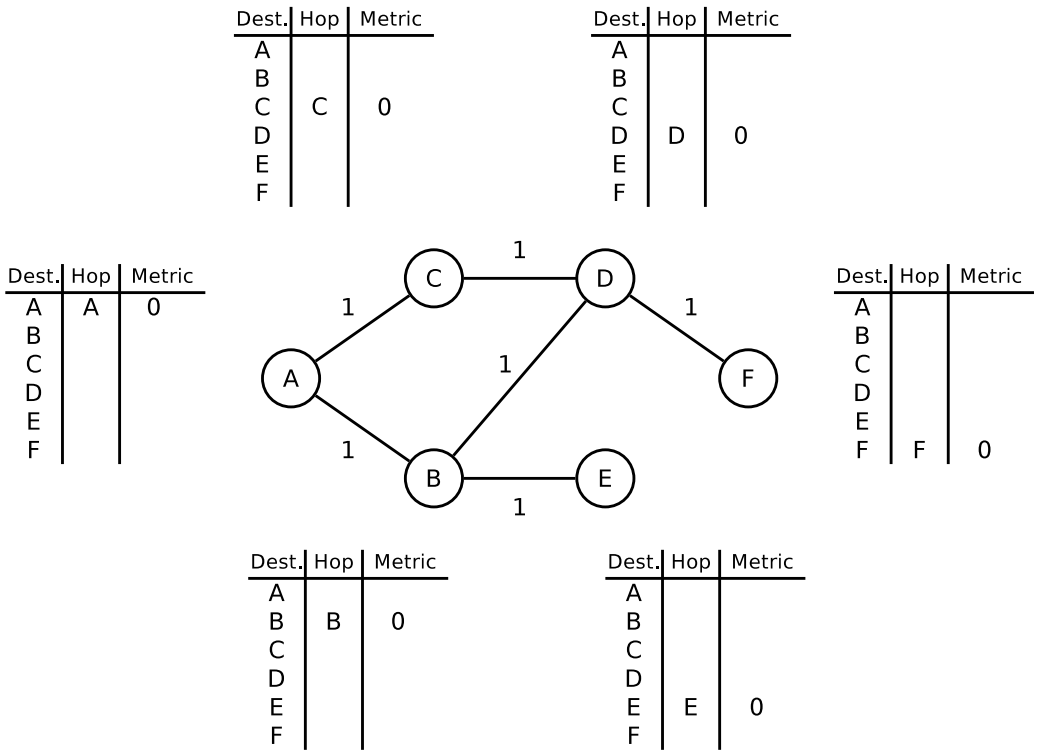
Step 2


Dest. Hop Metric
A
B
C C 0
D
E
F
Dest. Hop Metric
A
B
C
D D 0
E
F
Dest. Hop Metric
A A 0
B
C
D
E
F
1
C
D
1
1
A
1
F
1
B
E
1
Dest. Hop Metric
A
B
C
D
E
F F 0
Dest. Hop Metric
A
B B 0
C
D
E
F
Dest. Hop Metric
A
B
C
D
E E 0
F

Step 3


Dest. Hop Metric
A
B
C C 0
D
E
F
Dest. Hop Metric
A
B
C
D D 0
E
F
Dest. Hop Metric
A A 0
B
C
D
E
F
1
C
D
1
1
A
1
F
1
B
E
1
Dest. Hop Metric
A
B
C
D
E
F F 0
Dest. Hop Metric
A
B B 0
C
D
E
F
Dest. Hop Metric
A
B
C
D
E E 0
F

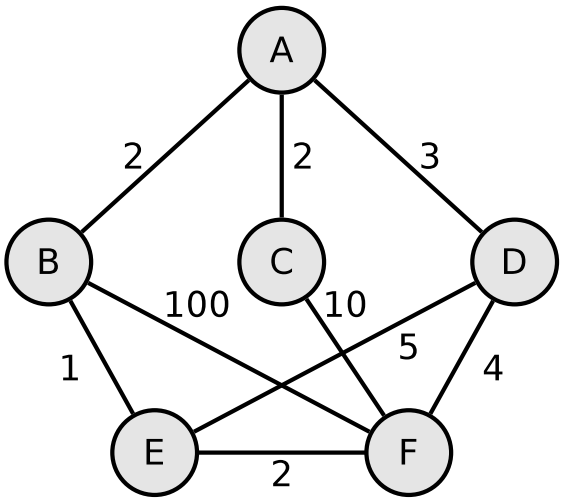
Step 4



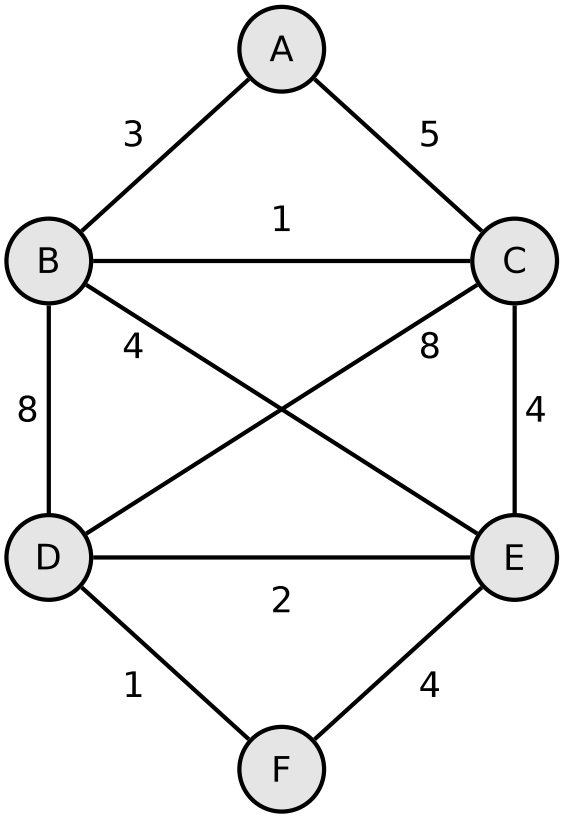
Exercise 9 (Dijkstra's Algorithm)

1. Calculate the shortest path from node A to all other nodes using Dijkstra's algorithm.

Source: Jörg Roth. Prüfungstrainer Rechnernetze. Vieweg (2010)



2. Calculate the shortest path from node A to all other nodes using Dijkstra's algorithm.



Exercise 10 (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 11 (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. Explain what **BGP hijacking** is and list two popular incidents where it was used and why.
4. What is the **ASN** our university's network reside in?