Forside H2025

UNIVERSITY OF OSLO
The Faculty of Mathematics and Natural Sciences
Written examination in IN1020
FALL 2025

Duration: December 8, 15:00-19:00
Permitted materials: No examination support material is allowed.

A calculator is available in Inspera (see at the bottom of the page).
It is important that you read the entire front page before you start answering the exam questions.

If you wish to zoom in on the question set, hold down ctrl and press + or - on the numeric keypad.

The lecturers will make a round from 16:00.

This examset

This examset consists of 4 sections, wheras each section gives upto 25 points and hence the total would be 100 points for this examset.

Section 1 regards Digital representation and assembly code
Section 2 regards Hardware and computer architecture
Section 3 regards Security.
Section 4 regards Computer network

Notice that each section must be passed in order to pass the whole exam.

The questions

The question are different variants of multiple choice questions. Some questions may have several correct answers, while others have only one. All will have at least one correct answer. You obtain points for each correct answer and can lose points for wrong ones, but you will never get less than 0 points for any problem.

Permitted aids

No examination support material is allowed.

Available resources in Inspera

- A simple calculator
- Ascii table

IN1020 H25 Seksjon Digital representasjon og assemblerprogrammering

You are now in section 1: Digital representation and assembly programming.

Tasks 1.1–1.8 are part of section 1.

1.1 IN1020 H25 bit-representasjon

A byte contains the following bits:

1	0	1	0	1	0	1	1

What value(s) in the decimal (base 10) system can be represented by these bits?

Select one or more alternatives:

- [ ] 99
- [ ] -85 ✔
- [ ] 171 ✔
- [ ] -42

Maximum marks: 2

1.2 IN1020 H25 Tallsystemer og 10

Choose the alternative(s) that is/are true for the number represented as **10** in different number systems:

Select one or more alternatives:

- [ ] $10_{15} = 15_{10}$ ✔
- [ ] $10_{3} = 3_{10}$ ✔
- [ ] $10_{2} = 2_{10}$ ✔
- [ ] $10_{23} = 23_{10}$ ✔

Maximum marks: 2.5

1.3 IN1020 H25 Tallsystemer representasjon

You are given a set of numbers, but unfortunately the notation that should tell us which numeral system they are written in has been lost. What numeral systems could these values be written in? There may be multiple correct alternatives for each group.

0f0cdb0d

- [ ] The decimal system (base 10)
- [ ] Hexadesimal numbers ✔
- [ ] Base 64 ✔
- [ ] Binary numbers

MTIz

- [ ] Base 64 ✔
- [ ] The decimal system (base 10)
- [ ] Binary numbers
- [ ] Hexadesimal numbers

10111010

- [ ] Base 64 ✔
- [ ] Hexadesimal numbers ✔
- [ ] Binary numbers ✔
- [ ] The decimal system (base 10) ✔

Maximum marks: 3.5

1.4 IN1020 H25 Enkoding

Check the statements that are true in the task below. There may be more than one correct answer.

Select one or more alternatives:

- [ ] We use an encoding, such as UTF-8 or ASCII, because we want to compress the text
- [ ] UTF-8 is an encoding that allows us to represent all characters in Unicode using between 1 and 4 bytes per character ✔
- [ ] It is common to use lossy compression to save space when storing text
- [ ] Unicode has room for all characters in the world ✔
- [ ] ASCII is always better than UTF-8 because ASCII uses less space

Maximum marks: 2

1.5 IN1020 H25 Lyd og bilde

Choose the statements that are true about the representation of sound and images:

Select one or more alternatives:

- [ ] Hz indicates the number of samples per second when converting from analog to digital sound ✔
- [ ] Vector graphics are well suited for storing photographs
- [ ] Lossy compression is often used to save space when transmitting or storing image ✔
- [ ] The bit depth of an audio recording is given in Hz
- [ ] Lossy compression is often used to save space when transmitting or storing audio ✔
- [ ] Image files are often stored using UTF-8 encoding

Maximum marks: 3

1.6 IN1020 H25 LMC instruksjonsplassering

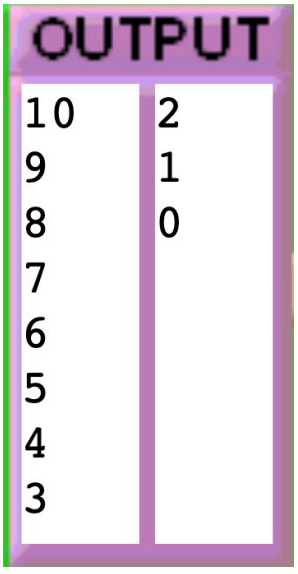
This program is supposed to count down from 10 to 0 and print all the numbers, as shown in the image below. However, it is missing one instruction and its argument. Fill the empty slots by dragging in the options listed at the top.

Help

STA | v1 | LDA | BRP | START | v10 | LOOP | BRZ

```
START   LDA  v10
LOOP    OUT
        SUB  v1
        BRP ✔   LOO ✔
        HLT

v1      DAT  1
v10     DAT  10
```



Maximum marks: 4

1.7 IN1020 H25 LMC Maskinkode

You are given the following LMC program as machine code:

```
507
922
508
922
509
922
000
073
102
105
```

You may assume that the program is stored starting at memory location 0 in the LMC's memory.

What does this program do?

You may refer to the following mapping between machine code and assembly code:
0xx: HLT
1xx: ADD
2xx: SUB
3xx: STA
5xx: LDA
6xx: BRA
7xx: BRZ
8xx: BRP
922: OTC

Select one or more alternatives:

- [ ] It counts up 7, 8, 9 and prints this on the screen
- [ ] It adds three numbers and prints their sum
- [ ] It prints the following text: Hei
- [ ] It is incorrectly coded and will not be able to run
- [ ] It prints the following text: Ifi ✔

Maximum marks: 2

1.8 IN1020 H25 LMC feil i programmet

We have looked at this program in the lecture, and it is supposed to print the text “Velkommen!”. But a small mistake has slipped in, causing the program to not work exactly as intended. Choose the correct statement(s) below that describe something true about the program.

```
Skriv   LDA txt
        BRZ Ferdig
        OTC
        LDA Skriv
        ADD 1
        STA Skriv
        BRA Skriv
Ferdig  HLT
v1      DAT 1 // Konstant 1
txt     DAT 86 // ’V’
        DAT 101 // ’e’
        DAT 108 // ’l’
        DAT 107 // ’k’
        DAT 111 // ’o’
        DAT 109 // ’m’
        DAT 109 // ’m’
        DAT 101 // ’e’
        DAT 110 // ’n’
        DAT 33 // ’!’
        DAT 0 // Slutt
```

Select one or more alternatives:

- [ ] The program prints “V” before it stops ✔
- [ ] The instruction “ADD 1” is incorrect because it reads an instruction from memory cell 1 instead of the constant value 1 ✔
- [ ] The program will result in an arithmetic overflow and attempt to execute an instruction that has a negative numeric value in memory ✔
- [ ] The instruction “STA Skriv” is incorrect because it overwrites an existing instruction in the program
- [ ] The program prints “Velkommen” but is unable to print the exclamation mark at the end

---

Maximum marks: 6

H25 - Seksjon Maskinvare

You are now in section 2 - Hardware and computer architecture.

The problem number 2.1 - 2.10 are part of section 2.

How to answer questions with confidence assessment:

- Read each question carefully before answering
- You should distribute a total of **100% confidence** across the different answer options
- If you are completely certain about one answer: give it 100% and the rest 0%
- If you are uncertain: distribute the percentages across multiple options based on how likely you think each option is correct
- Example: If you think B is most likely correct but are somewhat uncertain, you could distribute as follows: 75% on the one and 25% on the other and the rest 0%
- **Important:** The sum of all percentages must always equal exactly 100%
- **Strategy:** Be honest about your actual uncertainty – the scoring system rewards realistic self-assessment. If you guess blindly, you risk losing points.

2.1 H25 - CBA - Cache-miss

What does it mean when the CPU experiences cache-miss?

Distribute your confidence over the various answer alternatives

	0 %	25 %	50 %	75 %	100 %
Two processor cores try to access the same cache line simultaneously	✔				
Data is not found in cache and must be fetched from a higher memory hierarchy level					✔
Data is found in cache and can be read quickly	✔				
The cache memory is full and must be cleared	✔				
The cache coherence protocol fails	✔				

Maximum marks: 2

2.2 H25 - CBA - Adder

Why is a half-adder called "half"?

Distribute your confidence over the various answer alternatives

	0 %	25 %	50 %	75 %	100 %
It can only add half numbers	✔				
It uses only half as many logic gates	✔				
It lacks "carry in" (Carry in) as an input					✔
It can only handle 4-bit numbers	✔				
It only outputs half the result	✔				

Maximum marks: 2

2.3

H25 - CBA - ALU

What does the control signal in an ALU determine?

Distribute your confidence over the various answer alternatives

	0 %	25 %	50 %	75 %	100 %
What type of calculation should be done	✔				
Which address in memory should be used	✔				
Which operation the ALU should perform					✔
How fast the operation should be performed	✔				
How many bits the ALU should process	✔				

Maximum marks: 2

2.4 H25 - CBA - PC

What is the main function of the Program Counter (PC) in a CPU?

Distribute your confidence over the various answer alternatives

	0 %	25 %	50 %	75 %	100 %
Holds the address of the current instruction	✔				
Controls the speed of the processor	✔				
Stores the result of calculations	✔				
Counts the number of instructions that have been executed	✔				
Holds the address of the next instruction to be fetched from memory					✔

Maximum marks: 2

2.5 H25 - CBA - Universell porter

Why are NAND and NOR called "universal gates"?

Distribute your confidence over the various answer alternatives

	0 %	25 %	50 %	75 %	100 %
They work with both AC and DC current	✔				
They can operate on all data types	✔				
All other logic gates can be built using only NAND or only NOR					✔
They are used everywhere in modern computers	✔				
They are the only gates that can store data	✔				

Maximum marks: 2

2.6 H25 - CBA - Pipeline ytelse

What sets the limit on maximum speed in a pipeline?

Distribute your confidence over the various answer alternatives

	0 %	25 %	50 %	75 %	100 %
The number of instructions executed simultaneously	✔				
The fastest component in the pipeline	✔				
The slowest component/stage in the pipeline					✔
The total number of pipeline stages	✔				
The size of the cache memory	✔				

Maximum marks: 2

2.7 H25 - CBA - Seriell Adder

What is the main problem with a Ripple Carry Adder (serial adder) when the number of bits increases?

Distribute your confidence over the various answer alternatives

	0 %	25 %	50 %	75 %	100 %
It requires too many transistors	✔				
The carry bit must propagate through all full-adders					✔
It uses too much power	✔				
It cannot handle negative numbers	✔				
It can only add numbers of the same size	✔				

Maximum marks: 2

2.8 H25 - Minne/Cache

Assume that there are 100 instructions remaining to be executed. Based on historical data, we can expect a 60% L1-cache-hit rate, 20% L1-cache-miss rate, 10% L2-cache-miss rate, and 10% RAM-miss rate.

How many clock cycles will it take to execute the 100 instructions?

The memory hierarchy is as follows:
3 levels of cache, where each level adds a total delay of 10 clock cycles per instruction.
RAM adds a total delay of 1000 clock cycles per instruction.
Instructions that do not require memory access use 1 clock cycle per instruction.

Select one alternative:

- 10400
- 400
- 10360
- 10460 ✔
- 3060

Maximum marks: 3

2.9 H25 - Instruksjonsflyt

Between each pipeline stage, data is stored in Select alternative (cache, register, RAM),

and Select alternative (ALU, IR, RAM, PC) keeps track of the next instruction.

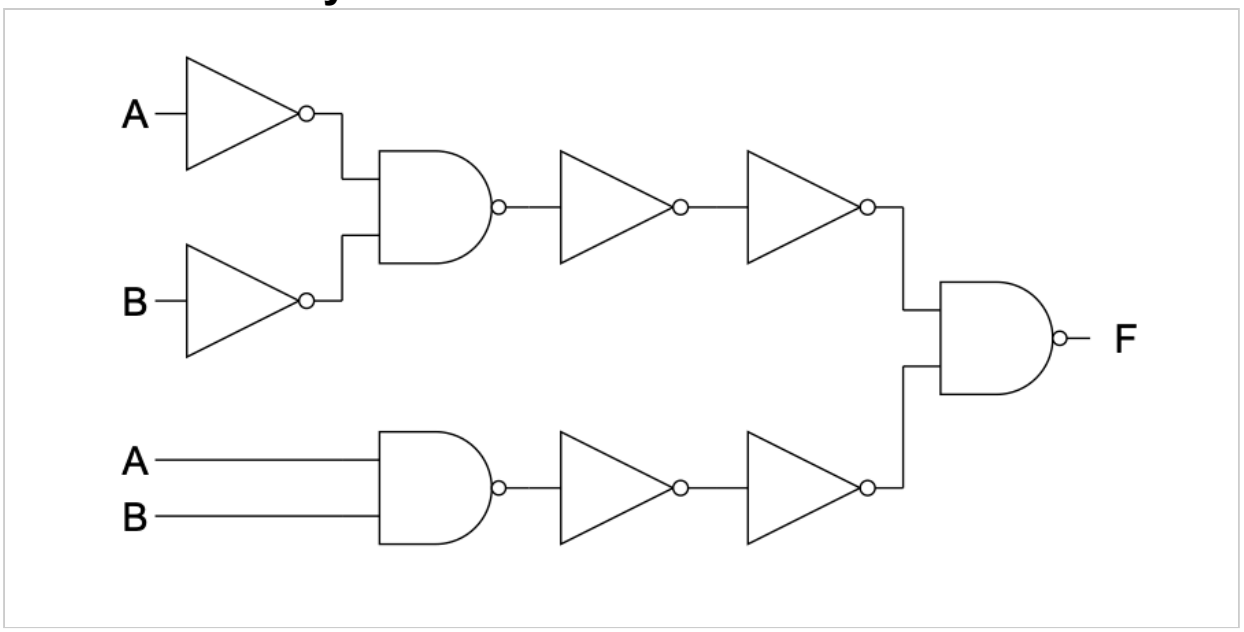
In the Select alternative (IF, DE, EX) stage, the Control Unit decodes the instruction and determines which operation to perform.

A data hazard occurs when an instruction needs Select alternative (an instruction, an address, a result) from a previous instruction. To solve this the processor can

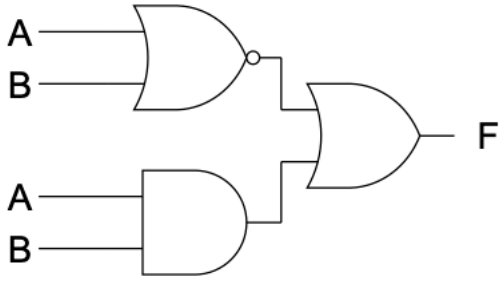
Select alternative (stop, ignore, jump, delete) the pipeline.

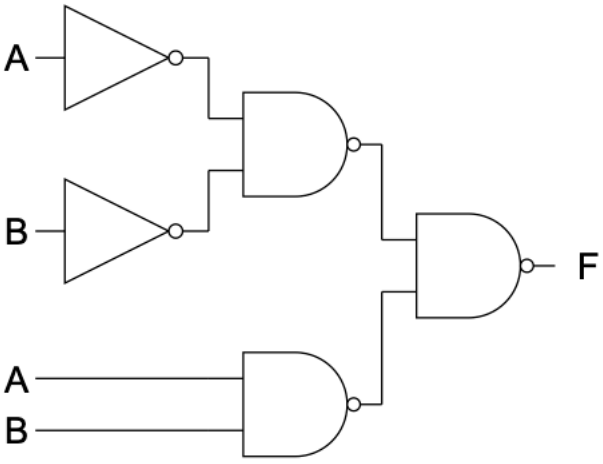
Maximum marks: 3

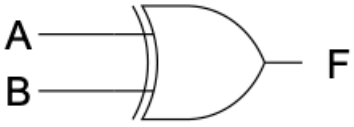
2.10 H25 - Kretsanalyse



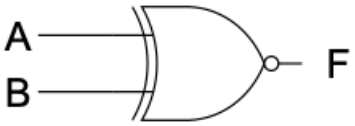
Which circuit realizes this function F using the fewest number of gates?







Halv-adder



Maximum marks: 5

Seksjon 3

You are now in section 3 - Security.

The problem number 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 and 3.8 are part of section 3.

3.1 Sikkerhetsmål

In IN1020 we define a number of security services, which are characteristics that will be maintained in most IT systems. Place the correct security service with the correct definition in the text below.

Help

Availability	Confidentiality	Personal data protection
Non-repudiation	Integrity	Authenticity

- Availability ✔ is the property that data and IT-services are usable upon request from an authorized entity.
- Confidentiality ✔ is the property that data is not made available to unauthorized entities.
- Authenticity ✔ is trust that an entity is real and as claimed.
- Integrity ✔ is the property that data has not been altered or deleted in an unauthorized manner.
- Non-repudiation ✔ is that an entity cannot deny having performed an action.
- Personal data protecti ✔ is the protection of personal data against unlawful collection and processing.

Maximum marks: 2

3.2 Brudd på sikkerhetsmål

Specify which security service is primarily violated as a result of each of the following attacks:

Please match the values:

	Konfidensialitet	Integrity	Availability	Authenticity
Denial of service attack	○	○	✔	○
Spyware	✔	○	○	○
Ransomware	○	○	✔	○
Modify network traffic	○	✔	○	○
Eavesdropping on network traffic	✔	○	○	○
Fake digital ID	○	○	○	✔

Maximum marks: 3

3.3 Begrepsforståelse

Place the terms below with the correct text. Note: Some of the terms will be left over.

Help

SQL injection	Data minimization	Attack vector
Authentication factor	Symmetric key	Authorization
Hash functions	Phishing	Purpose limitation
Authentication	Cross site scripting (XSS)	Vulnerability
Digital certificates	PKI	

Purpose limitation ✔ as a principle in the GDPR sets guidelines for what collected personal data can be used for.

Authentication ✔ is the mechanism for verifying a claimed identity.

Phishing ✔ is the name of a procedure for deceiving you into giving away confidential information.

Hash functions ✔ is used when it is necessary to check the integrity of a message.

Authentication factor ✔ is an evidence to confirm identity.

SQL injection ✔ can be used to obtain data directly from a database.

PKI ✔ is a infrastructure for ensuring the authenticity of public keys.

Attack vector ✔ is another word for the methods used to attack a computer.

Maximum marks: 4

3.4 Tilgangskontroll

a) What are the two basic elements of an access control system?
Select one alternative:

- Authorization and user identity
- Multi-factor authentication and biometrics
- Authentication and authorization ✔
- Password and private key

b) Which of the following is the correct definition of access control?
Select one alternative:

- Access control is enforcing defined access rights in a computer system. ✔
- Access control is creating rules for identifying users.
- Access control is defining a set of rules for password management.
- Access control is specifying access rights to computer resources.

c) Access control is primarily a [Select alternative] (corrective, detecting, preventive) security measure.

d) Errors in a system that handles access control can lead to violations of which security services?
Select one or more alternatives:

- Availability ✔
- Integrity ✔
- Confidentiality ✔

Maximum marks: 3

3.5 Anvendelse av kryptografi 1

a) Alice and Bob are going to exchange secret messages, and decide to use encryption with one secret shared key that they both - but no one else - know.

Alice encrypts a message with the secret key, and sends the encrypted message to Bob.

Select one or more alternatives:

- [x] Bob can be sure that the message comes from Alice. ✔
- [ ] Bob tries to convince Eve (a third party) that the message is from Alice. Eve can be sure that Alice is the originator.
- [x] Alice can be sure that the message can only be read by Bob. ✔

This way of sending messages ensures confidentiality of the message.

- ( ) False
- (•) True ✔

b) Alice and Bob find it difficult to exchange a shared secret key securely, and instead use public key encryption. Alice creates a key pair in which she keeps the private key secret while sharing the corresponding public key with Bob and Eve, among others.

Alice encrypts a message with her private key, and sends the encrypted message to Bob who decrypts it with the corresponding public key.

Select one or more alternatives:

- [ ] Alice can be sure that the message can only be read by Bob.
- [x] Bob can be sure that the message comes from Alice. ✔
- [x] Bob tries to convince Eve (a third party) that the message is from Alice. Eve can be sure that Alice is the originator. ✔

This way of sending messages ensures confidentiality of the message.

- ( ) True
- (•) False ✔

Maximum marks: 3

3.6 Anvendelse av kryptografi 2

Alice and Bob use asymmetric encryption for message exchange and signing, and have each been given a key pair consisting of a private and a public key.

a) To sign a document D, Alice have to use Select alternative (Alice's private, Bob's private, Bob's public, Alice's public) key. To verify that Alice has signed document D, Bob must use

Select alternative (Alice's public, Alice's private, Bob's public, Bob's private) key.

b) To encrypt and send a secret (confidential) message M to Bob, Alice have to use

Select alternative (Bob's public, Bob's private, Alice's public, Alice's private) key. To decrypt

and read the message M, Bob must use Select alternative (Alice's public, Alice's private, Bob's private, Bob's public) key.

Maximum marks: 2

3.7 Personopplysningsvern

An employer wants to register some additional information about their employees. They want to record the following data:

- Information about an employee's children.
- Contact information for their partner/spouse.
- Which trade union the employee is a member of.
- Information about health that may negatively affect the employee in their daily work.
- Religious beliefs in order to celebrate various holidays.

a) Is the employer automatically allowed to record this information about an employee?
Select one or more alternatives:

- [ ] Yes
- [ ] No ✔

b) The General Data Protection Regulation defines what are called *special categories of personal data*. Which of the following are defined in this category?
Select one or more alternatives:

- [ ] Exam result
- [ ] Political opinion ✔
- [ ] Religious beliefs ✔
- [ ] Email address
- [ ] Social security number
- [ ] Ethnic origin ✔

c) What requirements must be met in order to legally register and process personal data about natural persons?
Select one or more alternatives:

- [ ] Requirement that no more personal data is recorded than is necessary for the pro✔sing.
- [ ] No special requirements as long as the data subject has consented to the processing.
- [ ] Requirement that information security be maintained in processing. ✔
- [ ] Requirement that personal data, as a general rule, is not used for purposes other t✔n those for which it was collected.
- [ ] Requirement that information be archived in case new processing needs arise.

Maximum marks: 4

3.8 Trusselmodellering og risiko

You are a consultant in an IT company who will contribute to a threat assessment of information security at a company. The company processes data about its customers, who are both private individuals and other companies. In addition, they store a variety of data/information about their own business, which they wish to keep secret.

a) The company is very concerned about avoiding data leaks. What could be the threats to the *confidentiality* of the data the company processes?

Select one or more alternatives:

- [ ] Software vulnerability via the supply chain. ✔
- [ ] Denial of service attacks from outsiders.
- [ ] Phishing attacks against employees. ✔
- [ ] Password leak. ✔
- [ ] Ransomware attack.

b) What security measures would you recommend to reduce the likelihood and consequences of a breach of *confidentiality*?

Select one or more alternatives:

- [ ] Ensure that all employees have access to all company secrets.
- [ ] Conduct regular safety drills. ✔
- [ ] Use checksum algorithms for all data stored.
- [ ] Encrypt all data stored. ✔
- [ ] Introduce two-factor authentication for employee logins. ✔

c) What are the direct threats to the *availability* of the data the company processes and the IT services they offer?

Select one or more alternatives:

- [ ] Eavesdropping on network traffic between customer and company.
- [ ] Spyware on an employee's computer.
- [ ] Denial of service attacks from outsiders. ✔
- [ ] Interception of network traffic internally within the company.
- [ ] Ransomware attack. ✔

d) What security measures would you recommend to mitigate the consequences of *availability* breaches?

Select one or more alternatives:

- [ ] Encrypt all data stored.
- [ ] Have proper routines for backing up stored data. ✔
- [ ] Use checksum algorithms for all data stored.
- [ ] Conduct regular safety drills. ✔
- [ ] Introduce two-factor authentication for employee logins.

Maximum marks: 4

Seksjon 4

You are now in section 4 - Operating Systems and Data Communication.

Tasks 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7 and 4.8 are part of section 4.

4.1 Operativsystemer

Which statements about operating systems are true and which are false?

	True	False
The operating system ensures that several users can share a computer	✔	
It is the operating systems task to allocate resources to the programs that will run.	✔	
Mobile phones only run one program at a time, and therefore do not need an operating system.		✔
An operating system provides APIs for programs to use services such as storage and networking.	✔	
The operating system hides complicated hardware details to make developing software easier.	✔	
Common programs run in kernel mode because it is more efficient.		✔

Maximum marks: 3

4.2 Pakkeswitching

What is true for a packet switched network?

Select one or more alternatives:

- [ ] Data for transmission is split into smaller parts that are sent independently in the n ✔ ork.
- [ ] Different packets can take different paths from sender to receiver. ✔
- [ ] A dedicated connection is established between the sender and receiver.
- [ ] Capacity has to be reserved along the entire path.

Maximum marks: 2

4.3 Antall IP-adresser

You are going to order Internet from a new provider for your apartment, and you read on the provider's website that the new DHCP server is configured with a /25 network. (CIDR notation: /25).

How many IP addresses can the DHCP server allocate in this network? [ ] (126)

Maximum marks: 2

4.4 CIDR til punktnotasjon

When you connect a device to the network, you receive the following IP address: *10.110.100.15*

As mentioned in the previous task, you were informed by the network provider that a /25 network has been reserved. Your IP address in CIDR notation is therefore: *10.110.100.15/25*.

What is the subnet mask of your device in dot-decimal notation: [ ]

(255.255.255.128)

Maximum marks: 3

4.5 Nettverk + Broadcast

As mentioned in the previous task, you have connected a computer to the network and received the IP address: *10.10.100*.15.

The network is still a /25 network, and the IP address in CIDR notation is: *10.10.100*.15*/25*.

What is the subnet address of the network? [ ] (10.10.100.0)

What is the broadcast address of the network? [ ] (10.10.100.127)

Maximum marks: 6

4.6 TCP og UDP

Which of these services are offered both by TCP and UDP

Select one or more alternatives:

- [ ] Flow control
- [ ] Multiplexing over one IP-address (ports) ✔
- [ ] Checksum (data integrity) ✔
- [ ] Congestion control
- [ ] Reliability

Maximum marks: 2

4.7 Metningskontroll

The task of congestion control is to...

Select one or more alternatives:

- [ ] ... prevent that the receiver gets more data than it can accept.
- [ ] ... prevent that the network traffic stops because of overload (congestion collapse) ✔
- [ ] ... make sure that the resources in the network are shared equally between the da ✔ ows.
- [ ] ... count the number of data streams over a network interface.
- [ ] ... send data packets from the correct port in a router.

Maximum marks: 4

4.8 Diverse fra applikasjonslaget

Which claims from the application layer are true and which are false?

	True	False
The Domain Name System (DNS) uses only TCP as the transport protocol.	○	○ ✔
Pull is the most common connection strategy in the client-server model.	○ ✔	○
The Domain Name System (DNS) has a hierarchical structure.	○ ✔	○
HTTPS uses a public-key infrastructure (PKI) to exchange encryption keys.	○ ✔	○
A content delivery network (CDN) is used to make the distribution of content such as video more efficient.	○ ✔	○
Peer-to-peer (P2P) networks are the most common access model used.	○	○ ✔

Maximum marks: 3