i

INSTRUCTIONS

Part A

Part A consists of 7 subparts, corresponding to module 0-6 of the course, with 10 points each.

In order to pass this exam, you must:

1. Score at least 3 points in each of the 7 subparts in Part A (Part A.0 -- A.6)
2. Score at least 63 points in total in Part A (90% of the maximum score in Part A)

The majority of the problems are multiple choice. For each problem, there is one correct answer or statement.

If you think there is more than one correct answer, pick the best one. Based on the context and what has been covered in the course, use your judgement to select the best answer.

For questions that require an answer in writing, you may answer in English or Swedish. Write brief and clear answers; ambiguous answers will give zero points. Do not answer questions not asked in the exam; stick to answering the asked questions.

Part B

Part B consists of five questions around a common scenario.

In order to get grade 4 or 5 on this exam, you must:

1. Pass Part A according to above
2. Out of the 20 points that is the maximum score for Part B, get at least 10 points for grade "4" and at least 15 points for grade "5".

☑ **Assumptions**

If you think that some essential information is missing from a question, you should make a reasonable assumption that supports your answer.

In the case that you have to do such an assumption, state that assumption in the text field below. Remember to for each assumption clearly state which question it is related to.

State assumptions here

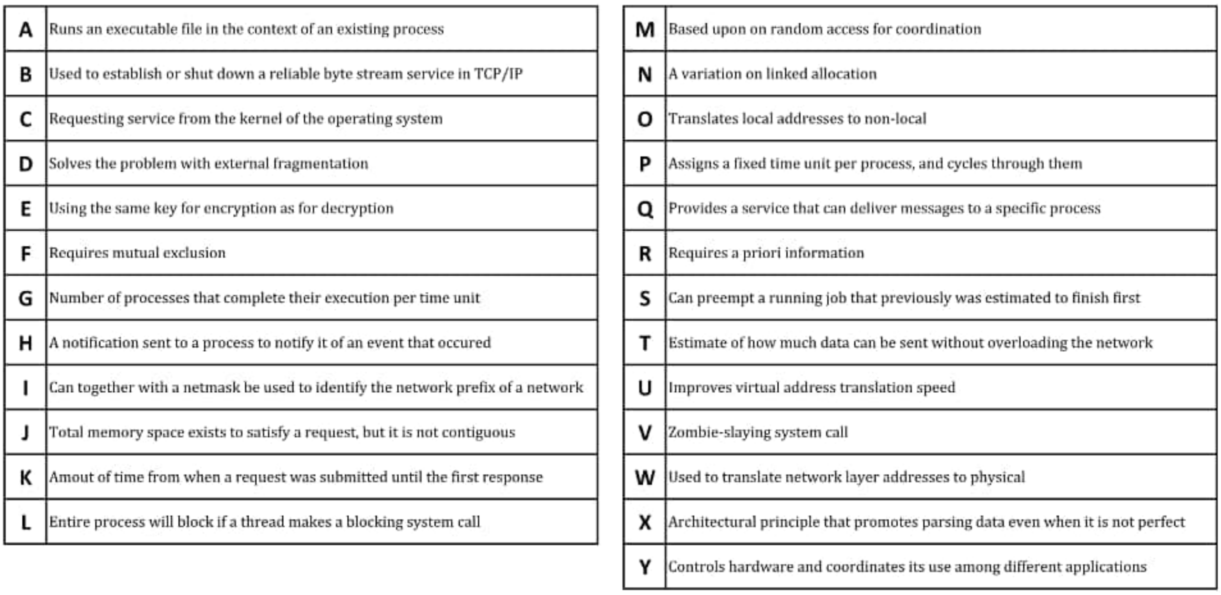
□

Part A

...in which you demonstrate yourself worthy to pass the exam by:

- **Score at least 3p in each of the 7 subparts**
- **Getting at least 63 points (out of 70) in Part A**

1 In the below table you find 25 statements. Each statement is identified by a single letter label (A-Y).



A	Runs an executable file in the context of an existing process	**M**	Based upon on random access for coordination
B	Used to establish or shut down a reliable byte stream service in TCP/IP	**N**	A variation on linked allocation
C	Requesting service from the kernel of the operating system	**O**	Translates local addresses to non-local
D	Solves the problem with external fragmentation	**P**	Assigns a fixed time unit per process, and cycles through them
E	Using the same key for encryption as for decryption	**Q**	Provides a service that can deliver messages to a specific process
F	Requires mutual exclusion	**R**	Requires a priori information
G	Number of processes that complete their execution per time unit	**S**	Can preempt a running job that previously was estimated to finish first
H	A notification sent to a process to notify it of an event that occured	**T**	Estimate of how much data can be sent without overloading the network
I	Can together with a netmask be used to identify the network prefix of a network	**U**	Improves virtual address translation speed
J	Total memory space exists to satisfy a request, but it is not contiguous	**V**	Zombie-slaying system call
K	Amout of time from when a request was submitted until the first response	**W**	Used to translate network layer addresses to physical
L	Entire process will block if a thread makes a blocking system call	**X**	Architectural principle that promotes parsing data even when it is not perfect
		Y	Controls hardware and coordinates its use among different applications

Pair each of the 10 concepts below with the statement (A -Y) above that best describes the concept or best relates to the concept. For each concept, answer by entering the chosen statement label (exactly one letter, A - Y). There are 10 concepts and 25 statements, hence only 10 of the 25 statements will be among the valid pairings.

Grading: Each correct pairing will result in **0.5 point**.

Concept	Statement
Critical section	□
Three-way handshake	□
Postel's law	□
External fragmentation	□
Operating systems	□
IP address	□
System call	□
FAT	□
Signal	□
Wait	□

Totalpoäng: 10

A.1. Fundamentals

2

An executing process:

○ resides is in memory.

○ is an active entity stored on secondary storage.

○ is the result of compiling a program.

○ is a passive entity stored on secondary storage.

Totalpoäng: 1

3

Multitasking:

○ has higher CPU utilization compared to multiprogramming.

○ requires multiple CPUs or CPU cores.

○ is an extension of multiprogramming.

○ allows for a single job to get stuck in an infinite loop and block all other jobs from executing.

Totalpoäng: 1

4

Which of the below statements about system calls is true?

○ An interrupt is used to initiate a system call.

○ System calls are implemented using a special function call from user space to kernel space.

○ Prior to handling a system call, the caller places the return address on the stack.

○ An exception is used to initiate a system call.

Totalpoäng: 1

5

A synchronous event:

○ can only be caused by a timer.

○ is used to synchronize access to a critical section.

○ always occurs at regular intervals.

○ is directly related to the instruction currently being executed by the CPU.

Totalpoäng: 1

6

Why do we want to use a sliding window at the sender side?

○ To support pipelined transmissions with selective repeat

○ To support varying delays in the network

○ To support usage of cumulative acknowledgments

○ To support reordering of datagrams in the network

Totalpoäng: 1

7

A transition from user mode to kernel mode:

○ can be caused by a system call or interrupt but not by an exception.

○ is initiated by the kernel.

○ can be caused by an interrupt, exception or a system call.

○ can only be initiated by a system call.

Totalpoäng: 1

8 The Internet protocol stack

The picture below illustrates the four layers in the Internet architecture protocol stack. In the left column, specify the name of each layer. In the right column, specify what is sent at each layer from in the case of an application that uses TCP. Answer by dragging the right term to each box.

⌨ Hjälp

Uppermost layer		sends:	
		sends:	
		sends:	
Lowermost layer		sends:	

Network	Frame	Session	Application	Link
Transaction	Message	Packet	Transport	Segment
Request	Transmission	Control	Routing	Physical
Presentation	Client	Socket		

Totalpoäng: 1

9

What is a protocol?

○ An API for network communication

○ A set of rules that dictates what should happen when a certain type of message is received

○ A specification of how information is passed between different layers in the network stack

○ A mechanism that is responsible for a specific feature in the network stack

Totalpoäng: 1

10

What is true for both Selective-repeat and Go-Back-N?

○ We do always not wait for an ACK before sending the next message

○ Only lost messages are retransmitted

○ The window size is fixed

○ We can only have one un-ACK:ed message outstanding

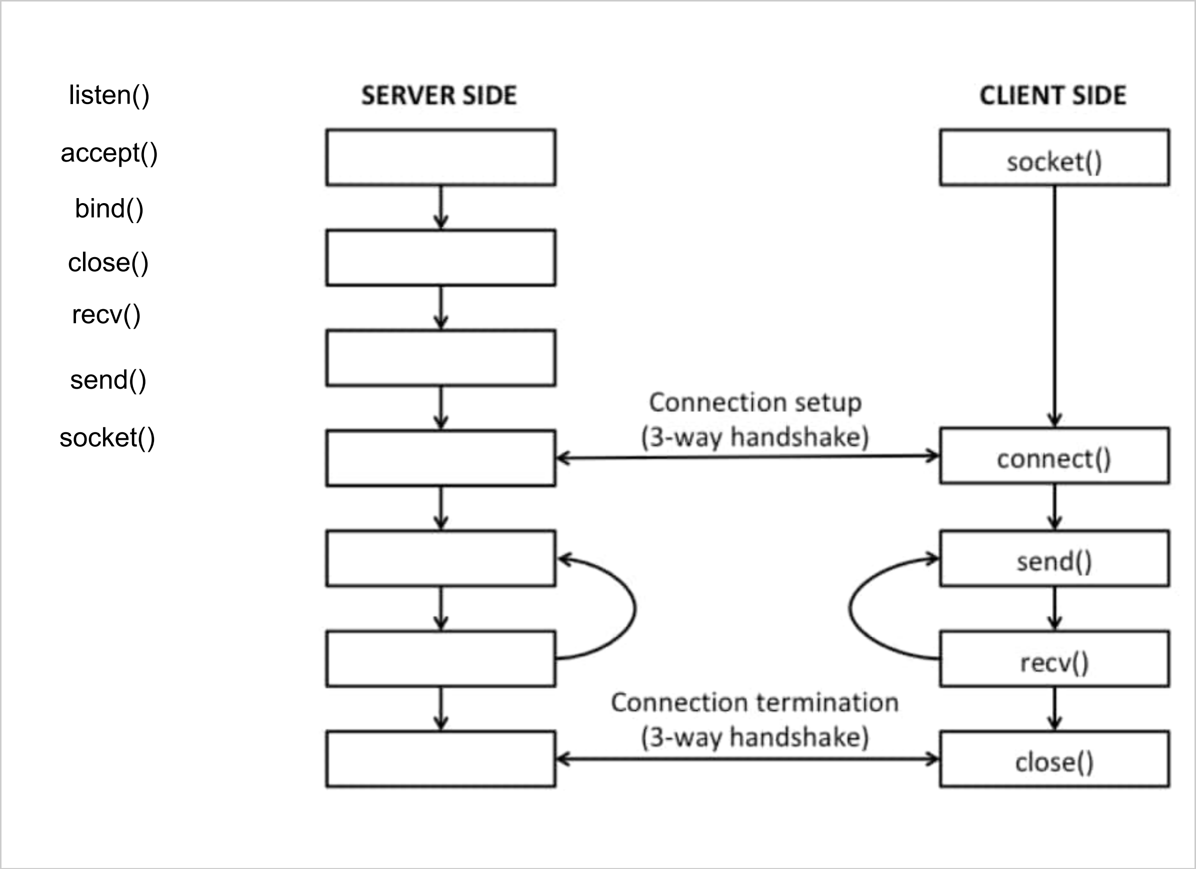
Totalpoäng: 1

A.2. The process concept

11 **TCP server using Sockets API**

The image below illustrates the system calls involved in setting up a TCP session between a server and a connecting client. Place the system calls on the server side in the correct order. 0.25p for each correctly placed system call, 2p if all are correct.

Drag each system call to the correct empty box



Totalpoäng: 2

12

The size of the data segment:

○ may shrink but not grow during runtime.

○ is the same for all processes.

○ is know at compile time.

○ may grow during runtime if necessary.

Totalpoäng: 1

13

Interactive and batch processes

○ In general, batch processes has higher priority than interactive processes.

○ A batch process is always CPU-bound.

○ In general, there is no way to distinguish between interactive and batch processes.

○ A batch process is always IO-bound.

Totalpoäng: 1

14

A single pipe:

○ should only be used for unidirectional communication.

○ is always represented by a single row in the file descriptor table.

○ can safely be used for duplex communication.

○ can only have one open write descriptor attached.

Totalpoäng: 1

15

The file descriptor table:

○ is reset when calling exec().

○ is kept in user space.

○ is not copied when calling fork().

○ is copied when calling fork().

Totalpoäng: 1

16

What is the main purpose of port numbers in TCP/IP?

○ Process multiplexing

○ Address translation

○ Service association

○ Integrity checking

Totalpoäng: 1

17

What is true about the differences between TCP and UDP?

○ TCP is segment-oriented, UDP is datagram-oriented

○ TCP is secure, UDP is insecure

○ TCP uses a checksum for integrity check, UDP has no checksum

○ TCP establishes a connection before transmission, UDP does not

Totalpoäng: 1

18

What is an example of a TCP congestion control mechanism?

○ Reducing the congestion window when observing an increase in measured RTTs

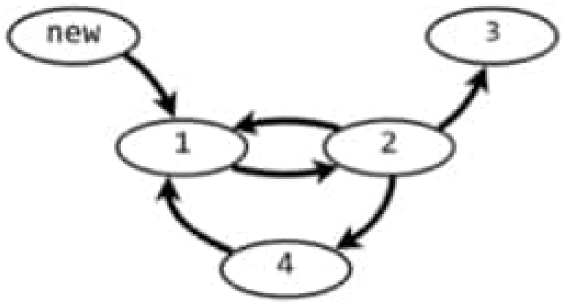
○ Reducing the congestion window when the receiver indicates a near-full buffer

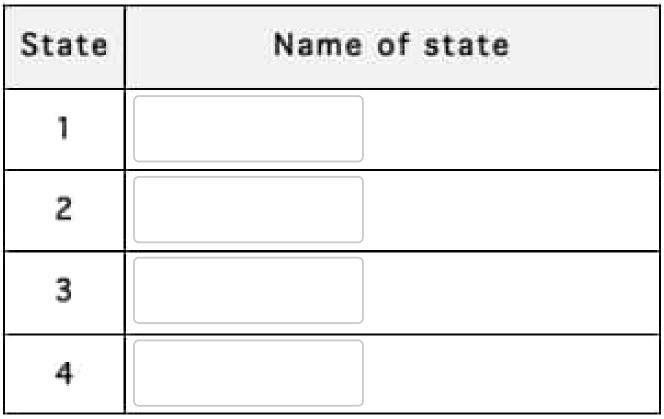
○ Reducing the congestion window by 50% in the case of three duplicate acknowledgments

○ Reducing the congestion window significantly in the case of a timeout

Totalpoäng: 1

19 A process can transition between various states as depicted in the diagram below. Type in the names of each state in the table to the right of the diagram.





State	Name of state
1	□
2	□
3	□
4	□

Totalpoäng: 1

A.3. Scheduling and routing

20

IPv4 addresses are divided into network and host identifiers.

○ The network identifier can be extracted using a netmask

○ The host identifier can be extracted using longest prefix matching

○ The network identifier is always shorter than the host identifier

○ The host identifier can be extracted by using ARP

Totalpoäng: 1

21 A network interface is configured to have the IPv4 address *A* with the netmask *M*, where both *A* and *M* can be represented as 32-bit binary numbers.

Now, the computer wants to send an IP packet to a computer with IP address *B*. Which of the following statements is true if the packet can be sent directly to *B* without being sent to the default router for *A.*

Which statement is true if A does not have to send packets to B through its default router?

○ (A AND M) is identical to (B AND M)

○ (A OR M) is identical to (B OR M)

○ (A XOR M) is identical to (B XOR M)

○ (A AND M) is identical to (B OR M)

AND, OR and XOR are bitwise operations that works as follows:

x	y	x AND y	x OR y	x XOR y
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

Totalpoäng: 1

22 In a CPU scheduling simulation of **RR with q = 3**, processes arrives to the ready queue according to the following table.

PID	Arrival time	CPU burst
1	0	4
2	3	2
3	4	5
4	8	6
5	12	3

Time slot 1 begins at time 0 and ends at time 1, time slot 2 begins at time 1 and ends at time 2, ..., time slot N starts at time N - 1 and ends at time N, ..., time slot 20 starts at time 19 and ends at time 20.

If a process is preempted at the same time as a process arrives to the ready queue, the arriving processes should be placed ahead of the preempted process in the ready queue. This means that a process that arrives to the ready queue at the beginning of time slot *N* will always be added to the ready queue before a preempted process that executed in time slot *N-1* is added to the ready queue.

In the simulation trace bellow, fill in the PID of the processes that will execute in each time slot using **RR, q = 3**.

Grading: Every correct answer gives 0.1 points. All corrects gives 2 points on the problem.

Time slot	PID
1	□
2	□
3	□
4	□
5	□
6	□
7	□
8	□
9	□
10	□
11	□
12	□

Time slot	PID
13	□
14	□
15	□
16	□
17	□
18	□
19	□
20	□

Totalpoäng: 2

23

Multilevel feedback queue scheduling:

○ uses time slicing among the multiple queues.

○ is used in scenarios where the processes can statically be classified into groups based on properties like process type, CPU time, IO access, memory usage size, etc.

○ dynamically separates processes into categories based on their need for the CPU.

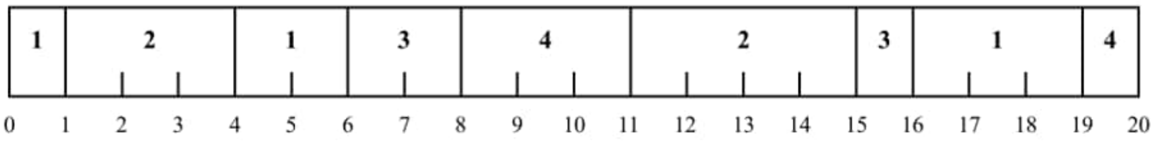
○ Give preference to long CPU bursts.

Totalpoäng: 1

24 In a CPU scheduling simulation processes arrives to the ready queue according to the following table.

PID	Arrival	CPU burst
1	0	6
2	0	7
3	3	3
4	6	4

The simulation results in the following Gantt chart.



From the above Gantt chart, calculate the average waiting time and the average response time.

Tip: Remember that 1/2 = 0.5, 1/4 = 0.25, 3/4 = 0.75.

Average response time: □ .

Average waiting time: □

Grading: Each correct answer will result in 1 point.

Totalpoäng: 2

25

When using FCFS scheduling, scheduling CPU bound process before I/O bound processes:

○ does not affect the average waiting time.

○ the average waiting time increases.

○ the average waiting time decreases.

○ makes the IO bound process spend less time in the ready queue.

Totalpoäng: 1

26 Three computers on the same network have the same netmask/prefix length and the IP addresses:

10.0.128.2

10.0.190.14

10.0.93.12

What is the maximum length of their shared netmask/prefix length?

○ 15 bits

○ 16 bits

○ 17 bits

○ 18 bits

Totalpoäng: 1

27 Your laptop connects to the Internet through WiFi. One day, you bring your laptop to a friend and connect to hers WiFi to collaborate on an assignment.

Which of the following statements are true?

○ Assuming your friend uses the same address range for her network (e.g., 192.168.0.0/16), you do not have to update the ARP table entry of the default router when connecting to your friend's network.

○ Your computer will receive a new IP address when connecting to your friend's network.

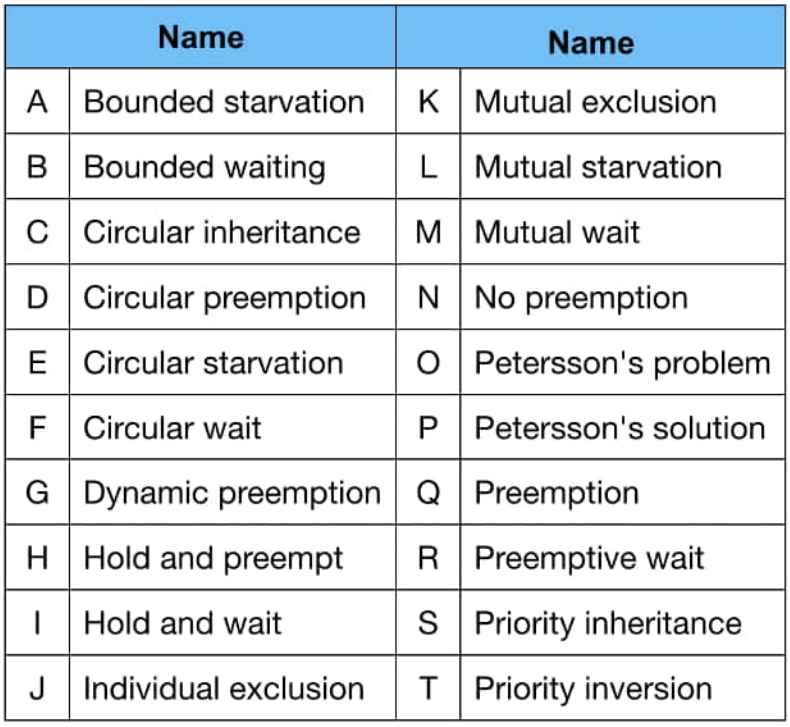
○ Your computer will receive a new MAC address when connecting to your friend's network.

○ To keep your old IP address, you must tunnel packets through the ISP's VPN server.

Totalpoäng: 1

A.4. Threads, synchronization and deadlock

28 **Deadlocks**



Name		Name	
A	Bounded starvation	K	Mutual exclusion
B	Bounded waiting	L	Mutual starvation
C	Circular inheritance	M	Mutual wait
D	Circular preemption	N	No preemption
E	Circular starvation	O	Petersson's problem
F	Circular wait	P	Petersson's solution
G	Dynamic preemption	Q	Preemption
H	Hold and preempt	R	Preemptive wait
I	Hold and wait	S	Priority inheritance
J	Individual exclusion	T	Priority inversion

Use the letters (A - T) in the above table to name the four necessary conditions for deadlock.
One letter for each condition. The order of the names does not matter.

Condition 1: □

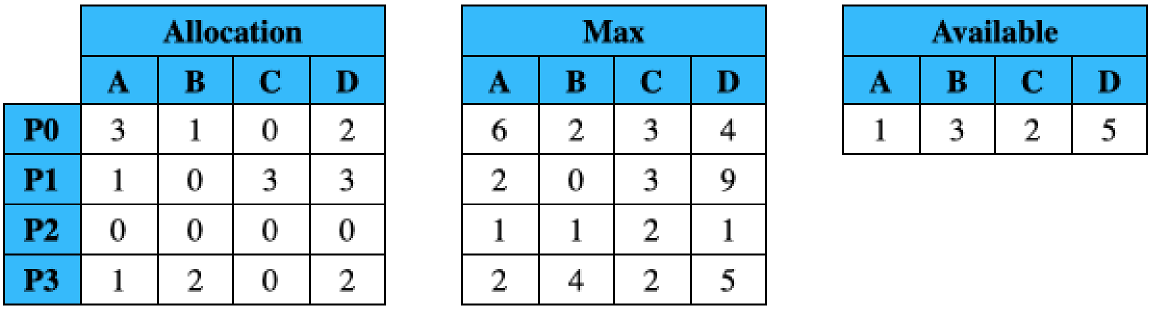
Condition 2: □

Condition 3: □

Condition 4: □

Totalpoäng: 1

29 The initial state S_o for a system using Banker's algorithm is defined by the below tables.



	Allocation			
	A	B	C	D
P0	3	1	0	2
P1	1	0	3	3
P2	0	0	0	0
P3	1	2	0	2

Max			
A	B	C	D
6	2	3	4
2	0	3	9
1	1	2	1
2	4	2	5

Available			
A	B	C	D
1	3	2	5

Assume process P_2 requests one more instance of resource A and one more instance of resource C, resulting in state S_1. Determine whether the new state S1 is safe by showing each step of the Banker's algorithm in the table below.

	Available				
Step	A	B	C	D	Choice
1					Välj alternativ ⌄ (P0, P1, P2, P3, Safe, Unsafe)
2					Välj alternativ ⌄ (P0, P1, P2, P3, Unsafe, Safe)
3					Välj alternativ ⌄ (P0, P1, P2, P3, Unsafe, Safe)
4					Välj alternativ ⌄ (P0, P1, P2, P3, Unsafe, Safe)
5					Välj alternativ ⌄ (P0, P1, P2, P3, Unsafe, Safe)

Grading: You must fill in the above table 100 % correct to get 2 points. Any mistakes will result in 0 points for the whole problem.

Totalpoäng: 2

30

Deadlock prevention:

○ is a dynamic method.

○ allows for more concurrency compared to deadlock avoidance.

○ requires additional a priori information.

○ allows for less concurrency compared to deadlock avoidance.

Totalpoäng: 1

31 In a system with two threads A and B each thread executes a loop N times. For each iteration:

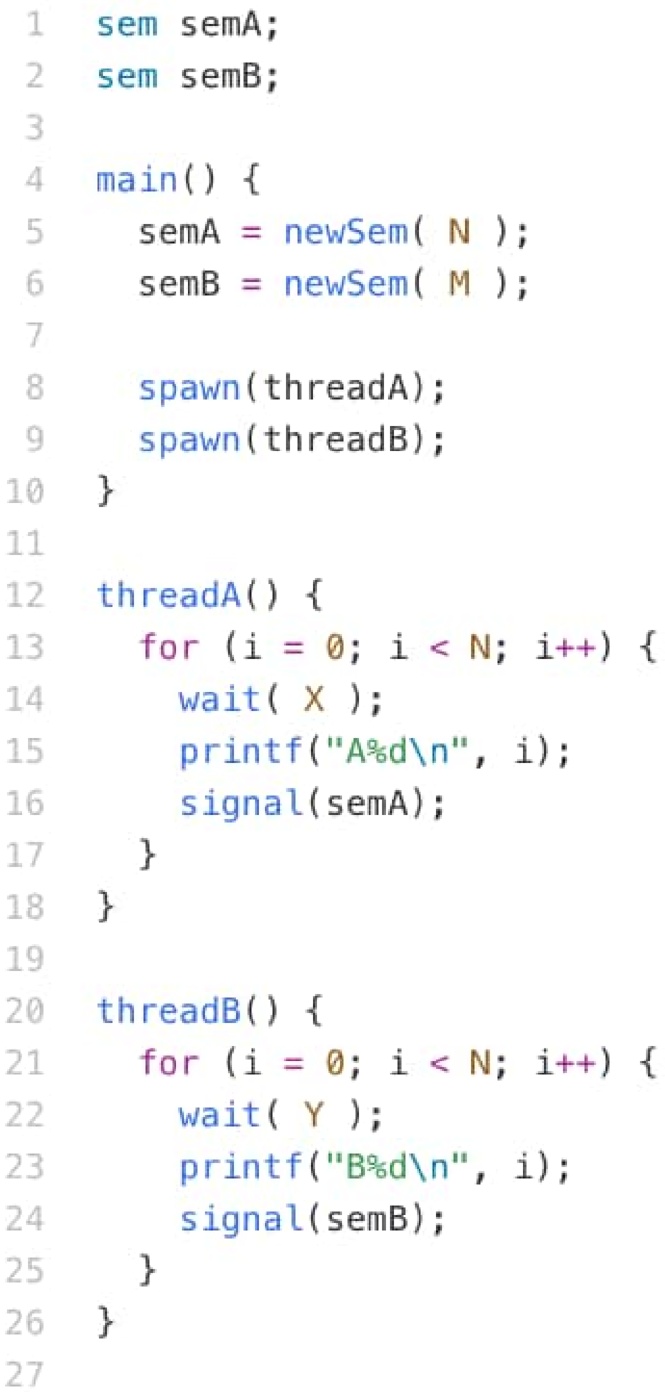
- thread A prints Ai where i = the iteration number 0, 1, 2, ..., N-1.
- thread B prints Bi where i = the iteration number 0, 1, 2, ..., N-1.

We now want to make the two threads have a rendezvous after each iteration, i.e., the two threads A and B should perform their iterations in lockstep. Lockstep means that they both first perform iteration 0, then iteration 1, then iteration 2, etc. For each iteration the order between A and B should not be restricted.

In the below table you find two examples of valid traces with proper rendezvous (Trace 1 and Trace 2) and two examples of invalid traces (Trace 3 and Trace 4) for N = 3:

Valid traces		Invalid traces	
Trace 1	Trace 2	Trace 3	Trace 4
A0	B0	A0	B0
B0	A0	A1	A0
B1	A1	B0	A1
A1	B1	B1	A2
B2	B2	B2	B1
A2	A2	A2	B2

Below you find C-like pseudo code for an attempted solution to the rendezvous problem.



```
 1  sem semA;
 2  sem semB;
 3
 4  main() {
 5    semA = newSem( N );
 6    semB = newSem( M );
 7
 8    spawn(threadA);
 9    spawn(threadB);
10  }
11
12  threadA() {
13    for (i = 0; i < N; i++) {
14      wait( X );
15      printf("A%d\n", i);
16      signal(semA);
17    }
18  }
19
20  threadB() {
21    for (i = 0; i < N; i++) {
22      wait( Y );
23      printf("B%d\n", i);
24      signal(semB);
25    }
26  }
27
```

To get the above implementation correct:

What value N (row 5) must be used to initialize semA: □

What value M (row 6) must be used to initialize semB: □

Which semaphore X (row 14) must be waited on by thread A:

Välj alternativ ⌄ (semA, semB)

Which semaphore Y (row 22) must be waited on by thread B:

Välj alternativ ⌄ (semA, semB)

Grading: Each correct answer will result in 0.5 point.

Totalpoäng: 2

32

Which of the following statements about data races and race conditions is true?

○ All data races are caused by race conditions.

○ Race conditions and data races are not a subset of one another, neither the necessary, nor the sufficient condition for one another.

○ Data races are a subset of the race conditions.

○ All race conditions are caused by data races.

Totalpoäng: 1

33

Which of the following statements about threads is correct?

○ Threads within a process share stack.

○ Depending on how threads are implemented, storage for the CPU context (registers) for each thread can be kept in either user space or kernel space.

○ On a single core CPU, threads can not execute concurrently.

○ Threads are always context switched in user space.

Totalpoäng: 1

34 Transaction properties

The ACID rule is used to remember four desirable properties of transactions. But what does the letters stand for?

Choose the right choice for each of the letter below.

Välj alternativ ⌄ (Authentication, Availability, Addressability, Adaptiveness, Atomicity, Abstraction)

Välj alternativ ⌄ **(Consistency, Checkable, Correctness, Computable, Concurrency, Circular)**

Välj alternativ ⌄ **(Interruptable, In-order, Interchangable, Intermittent, Isolation, Identifiable)**

Välj alternativ ⌄ **(Declarable, Definable, Deconstructable, Deterministic, Durability, Disk-storage)**

Totalpoäng: 1

35

Thread synchronization is required because:

○ All threads of a process share the same address space.

○ All threads of a process share the same global variables.

○ All threads of a process can share the same set of open files.

○ All of the above

Totalpoäng: 1

A.5. Memory management, file systems, history and governance

36 **IEC binary prefixes:** 1 KiB = 2^{10} Byte, 1 MiB = 2^{20} Byte and 1 GiB = 2^{30} Byte.

A system uses a 32 GiB virtual memory, 2^{19} pages and 8 MiB of physical memory.

Physical address size

How many bits are needed to address the physical memory?

Answer: □

Page size

Use two digits and select the unit to describe the page size.

The size of each page is □ Välj alternativ ⌄ (MiB, Byte, KiB, GiB)

Frame number

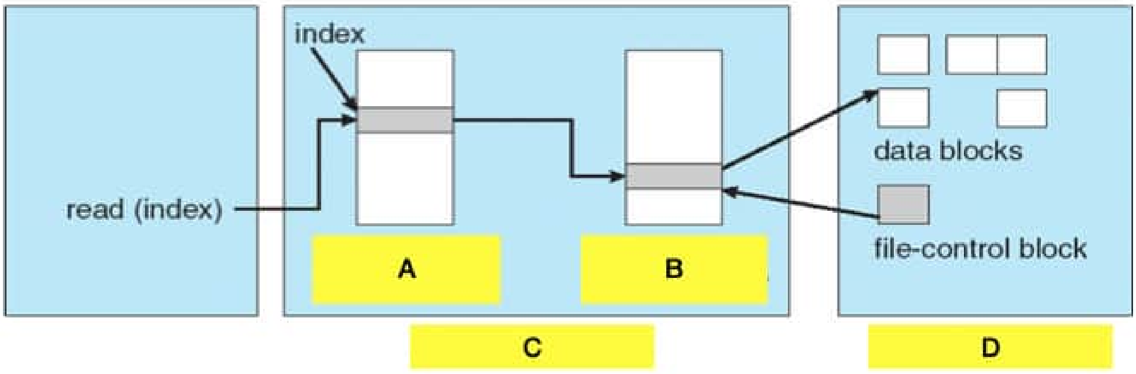
How many bits of the physical address is used to identify the frame number?

Answer: □

Grading: Each correct answer will result in 0.5 points.

Totalpoäng: 2

37 The below figure shows a number of file system data structures.



Select the correct description for each of the labels A, B, C and D.

	Directory structure	Kernel space	System-wide open file table	Secondary storage	Per-process open file table	User space	File control block
D	○	○	○	○	○	○	○
A	○	○	○	○	○	○	○
C	○	○	○	○	○	○	○
B	○	○	○	○	○	○	○

Grading: Each correct answer will result in 0.25 points.

Totalpoäng: 1

38

Paging:

○ requires a TLB.

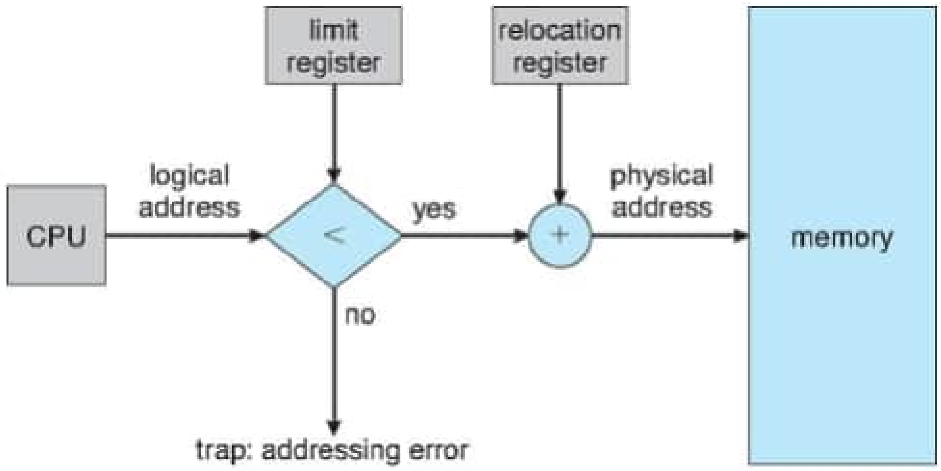
○ solves the problem with internal fragmentation.

○ divides the physical memory into pages with the same size as the logical frames.

○ none of the above.

Totalpoäng: 1

39



What method is implemented by the MMU above?

○ Segmentation.

○ Virtual memory.

○ Partitioned contiguous allocation.

○ Single contiguous allocation.

Totalpoäng: 1

40 Internet history

Below is a list of statements that relate to the development, and use, of the Internet. Associate each statement with a 5-year interval in the table by dragging the statements to the right box.

Hjälp

- A global increase in distance teaching and remote working
- The microblog service Twitter is launched
- The web is invented by Tim Berners-Lee
- Increased use of file sharing services increase the load on the Internet
- CYCLADES network is demonstrated
- More than 75% of all traffic in ARPANET is Email
- Sökmotorer börjar användas för att indexera och hitta information på Internet
- The first web page in Sweden
- The last IPv4 address in Europe is assigned
- ARPANET connects UCLA and Stanford
- Video streaming services like Netflix and HBO are widely introduced
- TCP/IP becomes standard in the Internet

Year	Event
1965-1969	
1970-1974	
1975-1979	
1980-1984	
1985-1989	
1990-1994	
1995-1999	
2000-2004	
2005-2009	
2010-2014	
2015-2019	
2020-	

Totalpoäng: 2

41 End to end principle

The end-to-end principle in computer networks was deduced from the end-to-end argument in system design, which is a classic guideline in the design of distributed systems and services.

Which of the following is an example of following the end-to-end principle in TCP/IP?

○ Using the IP TTL field to implement traceroute

○ Best-effort delivery of datagrams based on destination address only

○ Feedback from routers about status of forwarding queues

○ The domain name system (DNS)

Totalpoäng: 1

42

What Internet-related organisation is a part of the united nations organisation ?

○ The Internet Society (ISOC)

○ The Internet Research Task Force (IRTF)

○ The Internet Engineering Task Force (IETF)

○ The Internet Governance forum (IGF)

Totalpoäng: 1

43 The DARPA Internet Architecture had a top-level goal that guided the design of what later became the Internet.

Which of the following mechanisms that we have talked about in this course relate most to that top-level goal?

○ Node configuration using DHCP

○ IP subnetting using CIDR

○ TCP congestion control and avoidance

○ Best-effort datagram delivery

Totalpoäng: 1

A.6. Security

44

What does DNSSEC provide that ordinary DNS does not feature?

○ Authorization of DNS requests

○ Authentication of DNS data

○ Authentication of DNS servers

○ Encryption of DNS sessions

Totalpoäng: 1

45 **What is normally <u>not</u> included in a digital certificate issued by a CA?**

○ The public key of the owner of the certificate

○ Information about the identity of the owner of the certificate

○ A digital signature by the issuing CA

○ The public key of the issuing CA

Totalpoäng: 1

46 **What kind of premise does asymmetric cryptography rely on to be usable?**

○ The usage of algorithms that are well-known to anyone

○ The existence of one-way cryptographic hash functions

○ The existence of mathematical calculations that are very hard to inverse

○ The presence of a trusted root CA

Totalpoäng: 1

47 **During a HTTPS session setup, who authenticates whom?**

○ The connecting client authenticates the server

○ The server and client authenticates each other

○ A certifying authority authenticates the server

○ The server authenticates the connecting client

Totalpoäng: 1

48 Assume that a user wants to carry out a Denial-of-Service (DoS) attack against a server on another network, but lacks the opportunity to use many computers for this purpose.

Which of the following features of IPv4 could be (ab)used to deploy a small-scale DoS attack against the server?

○ IPv4 fragmentation

○ The IPv4 broadcasting address

○ The TTL field in the IPv4 header

○ Translating IPv4 addresses to FQDN

Totalpoäng: 1

49 Alice and Bob use the following authentication protocol:

1. Alice sends the message "I am Alice" to Bob
2. Bob chooses a one-time value R and sends it to Alice
3. Alice encrypts R with her private key and sends the result back to Bob
4. Bob decrypts the message using Alice's public key to verify her identity

What kind of attack could be used to break the authentication?

○ side-channel attack

○ replay attack

○ brute force attack

○ known-ciphertext attack

Totalpoäng: 1

50 **When using IPsec in transport mode:**

○ Fragmentation is not allowed

○ Senders can not be informed of packets dropped due to a zero TTL field

○ A network tunnel must be established for transporting encrypted IP packets

○ Only the payload of a packet is authenticated or encrypted

Totalpoäng: 1

51 **Usage of symmetric encryption for confidentiality requires:**

○ Integrity checking using a cryptographic hash function

○ Digital signatures verified by a root CA

○ Involving a third party for key management

○ A secure way to establish a shared secret

Totalpoäng: 1

52 **What of the following is not a factor used in a two-factor authentication system?**

○ Something you know

○ Something you are

○ Something you can compute

○ Something you have

Totalpoäng: 1

53 Your web client connects to a web server that presents a self-issued certificate to your web client. This results in the web client presenting a security warning about this to you before you proceed.

What should you as a user be aware of if choosing to proceed despite the warning?

○ That your login credentials have been compromised.

○ That the communication session will be unencrypted.

○ That someone may have hacked the web server and replaced its valid certificates.

○ That you may be communicating with another web server than you originally intended.

Totalpoäng: 1

i

Part B

...in which you demonstrate yourself worthy to get a higher grade by:

- **First having passed part A**
- **Scoring at least 10 points (out of 20) for grade "4"**
- **Scoring at least 15 points (out of 20) for grade "5"**

Samtliga frågor i del B handlar om det nedan presenterade scenariot. Läs igenom det ordentligt

så du har en tydlig bild av det innan du börjar besvara frågorna. Du kan svara på frågorna i del B på engelska eller på svenska.

Räddningsrobotar

Du har fått i uppgift att designa ett system bestående av tre räddningsrobotar som ska kunna användas i händelse av en naturkatastrof som en jordbävning eller ett vulkanutbrott. Naturkatastrofen har fått byggnader att rasa ihop, med överlevande kvar bland rasmassorna.

Räddningsrobotarna skickas in i rasmassorna och har till uppgift att tillsammans kartlägga området och hitta överlevande. När en robot hittar en överlevande skall information om detta samt var den överlevande finns omedelbart förmedlas till en operatör på utsidan så att räddningspersonal så snabbt som möjligt kan gå in och rädda den överlevande. Eftersom miljön är mycket farlig vill man att räddningspersonal ska tillbringa så lite tid som möjligt inne bland rasmassorna och det är viktigt att de får en tydlig karta över hur de ska röra sig.

Robotarna måste kunna fungera och samarbeta med varandra utan att vara beroende av fungerande fast infrastruktur såsom el, WiFi-nät, mobiltelefoni etc. eftersom det är sådant som ofta kan slås ut i samband med naturkatastrofer.

Robotarna är konstruerade för att kunna ta sig fram i den aktuella miljön och att de inte kommer att haverera. Däremot kan det inträffa att de i perioder kommer så pass långt ifrån varandra att direkt kommunikation inte är möjlig. Robotarna är försedda med sensorer för att kunna upptäcka väggar och hinder i alla riktningar, samt värmekamera och CO_2-detektorer för att kunna upptäcka överlevande. Vidare har de hårdvara för att kunna kommunicera trådlöst på ett av ISM-banden.

54 Kommunikation (4p)

Robotarna kan kommunicera med hjälp av Bluetooth eller WiFi. Vilken av dessa teknologier är att föredra? Hur kan du organisera kommunikationen mellan de olika robotarna samt med operatören på utsidan? Ha i åtanke att du vill att rasmassorna skall genomsökas och kartläggas så snabbt som möjligt och att överlevande måste kunna räddas så snart som möjligt.

Notera: I denna delfråga ska du besvara hur kommunikationen skall organiseras rent fysiskt, inte exakt vilka protokoll som skall användas (det kommer i en senare delfråga).

Hur organiserar du möjligheten för robotarna att kunna kommunicera? Om du behöver extra hårdvara, ange vad och varför.

Teckenf…

Σ

Ord: 0

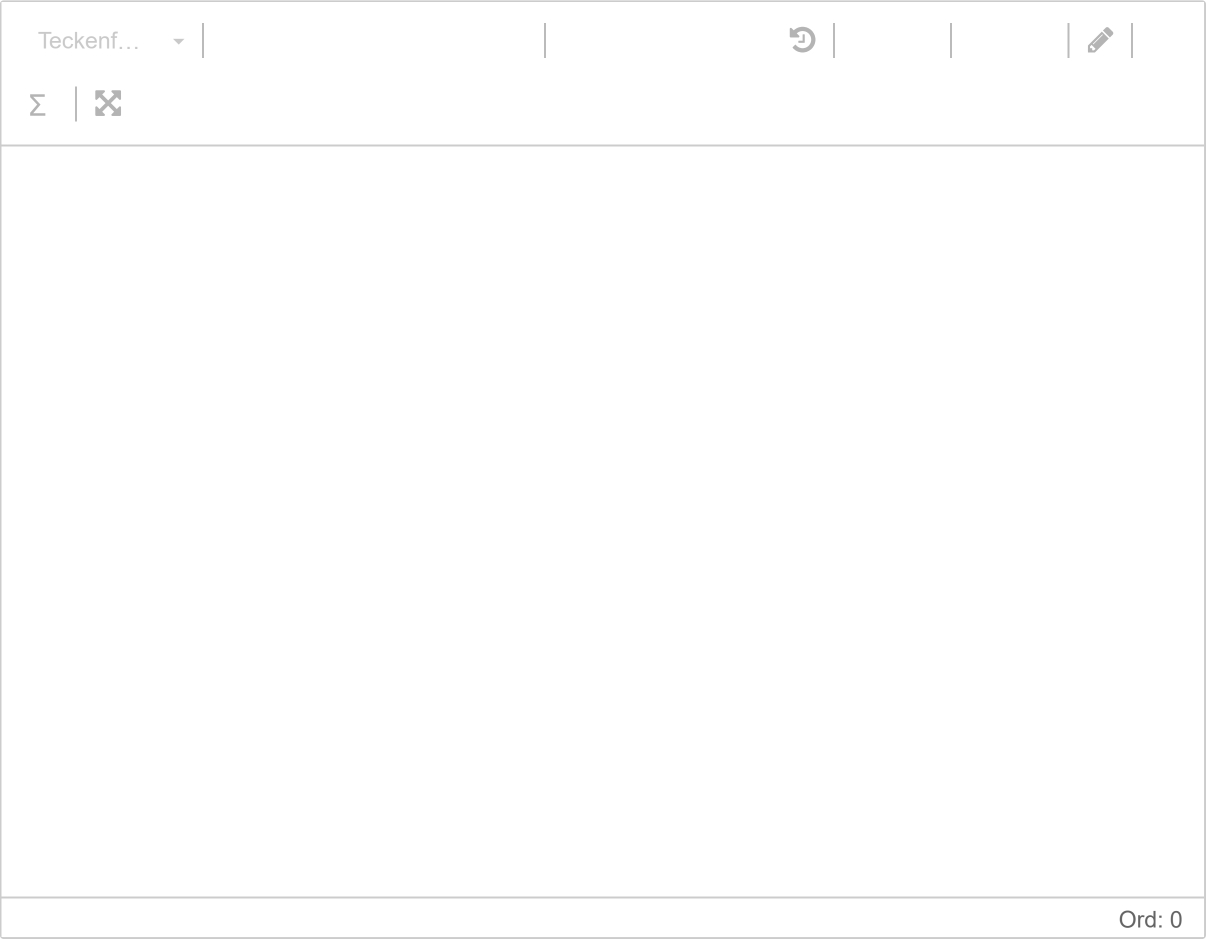
Totalpoäng: 4

55 **Synkronisering och koordination (4p)**

Under antagande att du har löst kommunikationsproblematiken i föregående uppgift kan robotarna nu utbyta information med varandra samt har kontakt med den utomstående operatören. Det kan hända att kommunikationen inte är kontinuerlig utan att en eller flera av robotarna tappar kontakten med varandra under kortare perioder, samt att operatören inte alltid kan nå minst en av robotarna.

Du vet att synkronisering och koordination är viktiga aspekter i ett distribuerat system och funderar över hur detta återspeglas i just detta scenario.

För var och ett av begreppen synkronisering (synchronisation) samt koordination (coordination), ange hur dessa relaterar till det aktuella scenariot. Vilka problem finns det att beakta? Du behöver inte kunna presentera en lösning på problemen, det räcker att kunna identifiera dem.



Totalpoäng: 4

56 Delade resurser (4p)

Eftersom robotarna samarbetar med varandra har de en delad resurs i form av en karta över rasmassorna som visar hur man kan ta sig fram bland rasmassorna samt var överlevande finns på kartan. Kartan byggs upp allteftersom robotarna rör sig och känner av hur deras näromgivning ser ut. För att snabba på kartritningen kartlägger de olika delar av miljön som sedan sammanställs i en gemensam karta. En utmaning du behöver tänka på kommer att vara hur de olika robotarnas respektive kartor skall kombineras.

Beskriv skissartat hur robotarna arbetar mot en gemensam karta även om de är på olika ställen. Tänk på att de ibland kan tappa kontakten med varandra.

Teckenf… Σ

Ord: 0

Totalpoäng: 4

57 Kommunikationstjänster (4p)

Under antagandet att de föregående tre problemen är lösta så är det nu dags att bestämma sig för hur kommunikationen mellan robotarna skall organiseras. Den tidigare frågan om kommunikation handlade främst om hur den fysiska strukturen, nu är det dags att fundera över vilka protokoll som skall användas. Du väljer att utgå från TCP/IP vilket innebär att du kan välja mellan TCP och UDP som transportprotokoll.

Väljer du TCP, UDP eller kanske en kombination mellan dem? Motivera ditt designbeslut tydligt. Om du använder en kombination, ange vad som varje protokoll används till, samt motivera ditt val.

Teckenf…

Σ

Ord: 0

Totalpoäng: 4

58 Bootstrapping (4p)

Under antagandet att de föregående problemen är lösta är det nu dags att slutföra din design genom att fundera över hur hela systemet skall startas upp. Om du antar att du kan ha olika antal robotar som kommer till en ny plats och skall inleda en ny räddningsinsats, vad behöver robotarna komma överens om med varandra innan de kan påbörja sitt arbete tillsammans?

Beskriv vad som händer när ett nytt uppdrag inleds i termer av vilken information som behöver utbytas, eventuell rollfördelning etc. Du kan anta att det finns ett enkelt sätt att informera en robot om att det är ett helt nytt uppdrag som inleds, exempelvis i form av en knapp man trycker på när man slår på den.

Teckenf…

Σ

Ord: 0

Totalpoäng: 4