INSTRUCTIONS

The exam consists of 7 subparts, corresponding to module 0-6 of the course, with 5 points each.

In order to pass this exam, you must:

1. Score at least 2 points in each of the 7 subparts
2. Score at least 31.5 points in total (90% of the maximum score)

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.

This reexam is only graded U/3.

Questions to the teacher during the exam are answered via email to lln@it.uu.se

☑ **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

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
B	Used to establish or shut down a reliable byte stream service in TCP/IP
C	Requesting service from the kernel of the operating system
D	Solves the problem with external fragmentation
E	Using the same key for encryption as for decryption
F	Requires mutual exclusion
G	Number of processes that complete their execution per time unit
H	A notification sent to a process to notify it of an event that occured
I	Can together with a netmask be used to identify the network prefix of a network
J	Total memory space exists to satisfy a request, but it is not contiguous
K	Amout of time from when a request was submitted until the first response
L	Entire process will block if a thread makes a blocking system call

M	Based upon on random access for coordination
N	A variation on linked allocation
O	Translates local addresses to non-local
P	Assigns a fixed time unit per process, and cycles through them
Q	Provides a service that can deliver messages to a specific process
R	Requires a priori information
S	Can preempt a running job that previously was estimated to finish first
T	Estimate of how much data can be sent without overloading the network
U	Improves virtual address translation speed
V	Zombie-slaying system call
W	Used to translate network layer addresses to physical
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	

Concept	Statement
Wait	

Totalpoäng: 5

Fundamentals

2

A transition from user mode to kernel mode:

- can only be initiated by a system call.
- can be caused by an interrupt, exception or a system call.
- is initiated by the kernel.
- can be caused by a system call or interrupt but not by an exception.

Totalpoäng: 1

3

System calls:

- 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

4

An executing process:

- resides is in memory.
- is a passive entity stored on secondary storage.
- is the result of compiling a program.
- is an active entity stored on secondary storage.

Totalpoäng: 1

5 Why do we want to use a sliding window at the sender side?
Välj ett alternativ:

- To support usage of cumulative acknowledgments
- To support reordering of datagrams in the network
- To support pipelined transmissions with selective repeat
- To support varying delays in the network

Totalpoäng: 1

6

What is a protocol?

- 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
- An API for network communication
- A set of rules that dictates what should happen when a certain type of message is received

Totalpoäng: 1

The process concept

7

Upon termination of a child process, when is the PCB deleted?

- When the parent calls exit().
- When the child calls exit().
- When the parent calls wait().
- When the child calls close().

Totalpoäng: 1

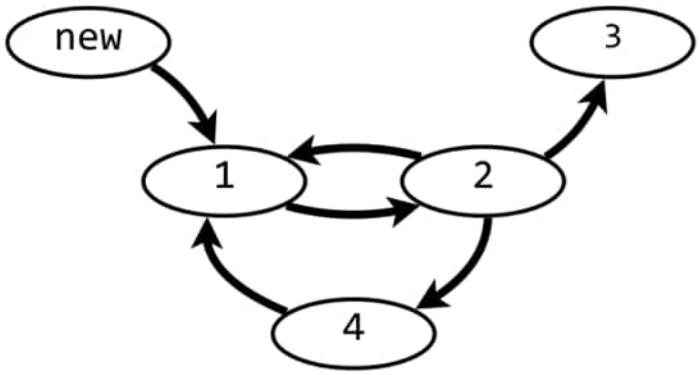
8

The size of the data segment:

- is the same for all processes.
- may shrink but not grow during runtime.
- may grow during runtime if necessary.
- is know at compile time.

Totalpoäng: 1

9



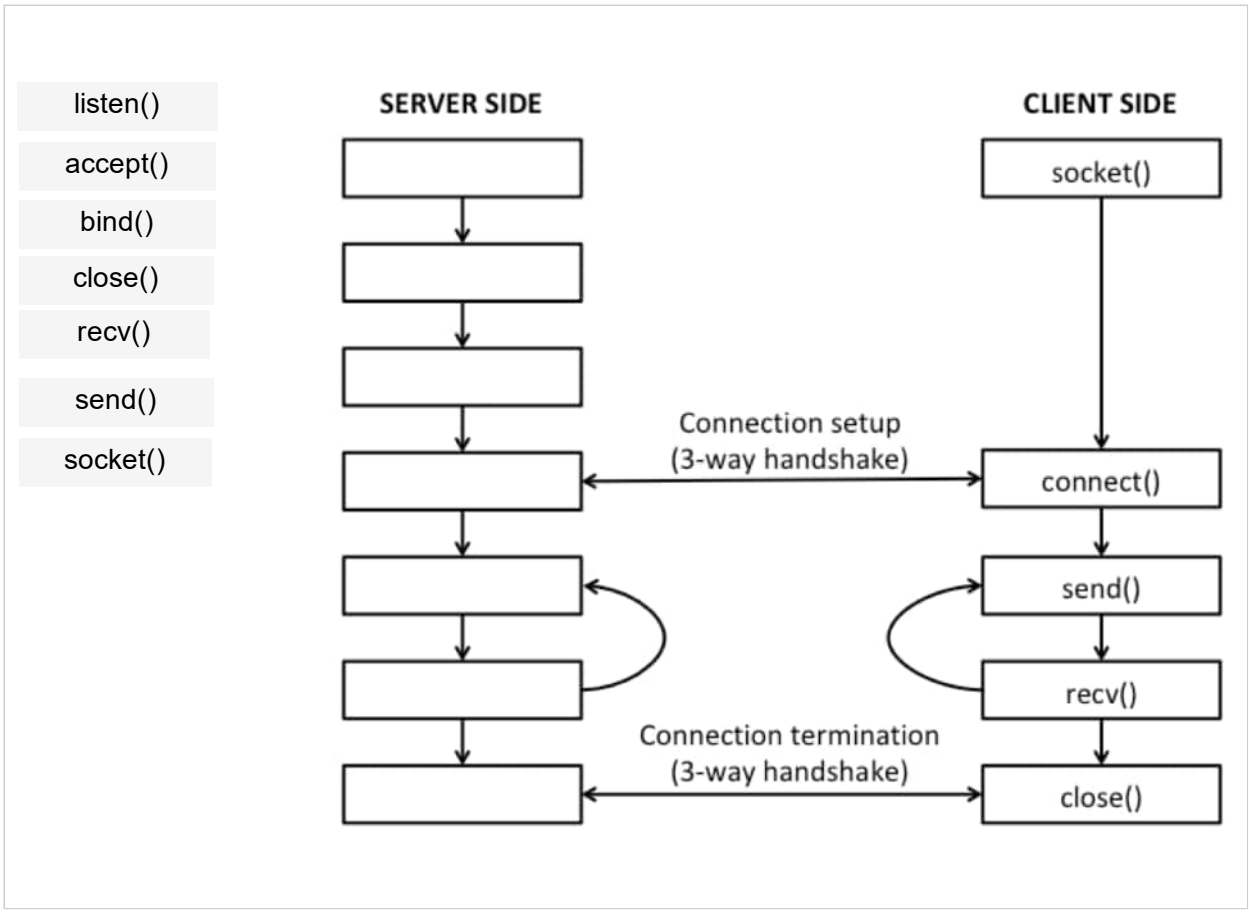
A process can transition between various states as depicted in the above diagram. The dispatcher moves a process from state [ ] to state [ ].

Totalpoäng: 1

10 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: 1

11 What is true about the differences between TCP and UDP?

Select one alternative:

- TCP uses a checksum for integrity check, UDP has no checksum
- TCP is segment-oriented, UDP is datagram-oriented
- TCP is secure, UDP is insecure
- TCP establishes a connection before transmission, UDP does not

Totalpoäng: 1

Scheduling and Routing

12

Interactive processes and batch processes.

- A batch process is always CPU-bound.
- In general, batch processes has higher priority than interactive processes.
- In general, there is no way to distinguish between interactive and batch processes.
- A batch process is always IO-bound.

Totalpoäng: 1

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

PID	Arrival	CPU burst
1	1	4
2	4	2
3	5	5
4	9	6
5	13	3

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: You must get the schedule exactly right to score 2 points. Even a small misstake will result in 0 points.

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

14 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 OR M) is identical to (B OR M)
- (A XOR M) is identical to (B XOR M)
- (A AND M) is identical to (B AND 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

15 IPv4 addresses are divided into network and host identifiers.
Select one alternative:

- The network identifier can be extracted using a netmask
- The network identifier is always shorter than the host identifier
- The host identifier can be extracted using longest prefix matching
- The host identifier can be extracted by using ARP

Totalpoäng: 1

Threads, Synchronization and Deadlock

16

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

17

Which of the following statements about threads is correct?

- 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.
- Threads are always context switched in user space.
- Threads are guaranteed to execute in parallel with each other.
- Threads within a process share stack.

Totalpoäng: 1

18 How is synchronization achieved in an Ethernet network?
Välj ett alternativ:

- By sensing for a carrier before attempting to transmit
- With a preamble in every Ethernet frame
- By asking for permission to transmit before sending data frames
- With exponential backoff in case of a detected collisions

Totalpoäng: 1

19 The readers-writers problem

A data set is shared among a number of threads. At any point in time, only one single writer can access the shared data set; any other writers or readers must be blocked. Allow multiple readers to read at the same time, any writers must be blocked.

Below you find the pseudo code for a system implementing the readers-writers problem.

In the init() function a mutex lock **mtx** is initialised to unlocked , a semaphore **wrt** is initialised to 1 and an integer **readers** is initialised to 0. The writers will execute the **writer()** function and the readers will execute the **reader()** function.

Att the correct pseudo code to the **reader()** function by dragging the corresponding line of code to each of the boxes to get a working implementation.

Hjälp

signal(wrt); wait(wrt); readers-- readers++ unlock(mtx); lock(mtx);

Bla bla bla

Initilisation	Writer	Readers

init() {
  mtx = new_mutex();
  wrt = new_semaphore(1);
  readers = 0;
}
	writer() {
	  wait(wrt);
	
	  // Write shared data
	
	  signal(wrt);
	}
		reader() {
		  [ ]
		  [ ]
		  if readers == 1 {
		  wait(wrt);
		  }
		
		  unlock(mtx);
		
		  // Read shared data
		
		  lock(mtx);
		  [ ]
		  if readers == 0 {
		  signal(wrt);
		  }
		  [ ]
		}

Totalpoäng: 1

20 What is an example of a key difference in CSMA/CA, when compared CSMA/CD, in the context of access networks?

In CSMA/CA, the sender...

- listens for activity on the physical medium before transmitting a frame
- partitions each frame into multiple transmissions to avoid starvation
- waits for a random time when a collision is detected
- asks for permission to send a frame before transmitting it

Totalpoäng: 1

Memory management, file systems, history and governance

21 **In Unix:**

- the file control block (FCB) contains pointers to inodes.
- files are not guaranteed to a have a single unique name.
- the file allocation table (FAT) contains pointers to inodes.
- files are guaranteed to a have a single unique name.

Totalpoäng: 1

22

The translation lookaside buffer:

- is needed to support shared pages contains a list of all free frames.
- is needed to support shared pages.
- is a replacement for the page table.
- is used to reduce the time taken to access a user memory location.

Totalpoäng: 1

23 What organisation has the ambition to "*assure the open development, evolution and use of the Internet for the benefit of all people throughout the world*" ?
Välj ett alternativ:

- The Internet Society (ISOC)
- The Internet Governance forum (IGF)
- The Internet Engineering Task Force (IETF)
- The Internet Research Task Force (IRTF)

Totalpoäng: 1

24 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?
Select one alternative:

- Using the IP TTL field to implement traceroute
- Best-effort delivery of datagrams based on destination address only
- The domain name system (DNS)
- Feedback from routers about status of forwarding queues

Totalpoäng: 1

25 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.

More than 75% of all traffic in ARPANET is Email

iPhone is launched and introduces the "mobile Web"

The web is invented by Tim Berners-Lee

ARPANET connects UCLA and Stanford

CYCLADES network is demonstrated

Video streaming services like Netflix and HBO are widely introduced

A sudden global increase in online teaching creates challenges for Internet service providers

The last IPv4 address in Europe is assigned

The first web page in Sweden

An internet dial-up set is "the christmas gift of the year" in Sweden

ADSL networks are introduced to private homes in Sweden

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-	

Year	
2014-2019	

2020	

Totalpoäng: 1

Security

26 What type of attack does salting protect against?
Select one alternative:

- Man-in-middle attacks
- Known plaintext attacks
- Side-channel attacks
- Dictionary attacks

Totalpoäng: 1

27 What is the main purpose of having CAs?
To simplify...

- management of private keys
- construction of keypairs
- verification of public keys
- establishment of private session keys

Totalpoäng: 1

28 What is normally not included in a digital certificate issued by a CA?
Välj ett alternativ:

- The public key of the owner of the certificate
- A digital signature by the issuing CA
- The public key of the issuing CA
- Information about the identity of the owner of the certificate

Totalpoäng: 1

29 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?
Select one alternative:

- The IPv4 broadcasting address
- Translating IPv4 addresses to FQDN
- The TTL field in the IPv4 header
- IPv4 fragmentation

Totalpoäng: 1

30 When using IPsec in transport mode:
Select one alternative:

- 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
- Fragmentation is not allowed
- Only the payload of a packet is authenticated or encrypted

Totalpoäng: 1