1 Page replacement

Consider a system with 3 physical page frames of memory. An application running on this system (alone) has the following page reference sequence (reference string - the order of page accesses):

(accessed first) **7 3 5 7 6 2 7 4 6 7 6 2 7 1 2 3 2** (accessed last)

What is the number of page faults that would occur for each of the following page replacement algorithms:

	8	9	10	11	12	13	14	15	16
1) First-in-first-out (FIFO)?	○	○	○	○	○	○	○	○	○
2) Second chance (clock)?	○	○	○	○	○	○	○	○	○
3) Least recently used (LRU)?	○	○	○	○	○	○	○	○	○

Maximum marks: 9

2 IPC

Which statements about inter-process communication (IPC) are true.
Select one or more alternatives:

- [ ] There is no difference between mailboxes and pipes.
- [ ] The **pipe()** system call creates two file descriptors.
- [ ] IPC mechanisms like pipes and mailboxes provide mechanisms for communication without using the TCP/IP protocols.
- [ ] A mailbox can be used to communicate one direction only.
- [ ] A message in a mailbox uses a process' PID (as an address) to determine which process that should receive the message.
- [ ] Tubing is a form of IPC used for communication between a process' child-processes.
- [ ] Messages used in mailboxes may have a "type".
- [ ] Mailboxes are used to store program parameters.
- [ ] Pipes store the "messages" sent between processes in a memory page in the operating system kernel.
- [ ] Signals are controlled by the interrupt handler.
- [ ] Shared memory is mapped/attached memory which can be used by several processes simultaneously.

Maximum marks: 5

3 Page table lookup

Assume you have a paging system with 16-bit addressing (16-bit address room) and 4 KB pages. There are 10 physical page frames in the system. The page table is given as follows:

Page table

Page table index	Present bit	Page frame
0	1	0001
1	0	0110
2	1	0000
3	1	1001
4	1	0010
5	1	1111
6	1	1000
7	1	0111
8	1	0011
9	0	0001
10	1	0100
11	0	1000
12	1	0101
13	0	0011
14	0	0101
15	1	0110

Exercise 1:
Given the following logical/virtual address,
0011 0001 1011 0011
what is the corresponding physical address (see alternatives below)?

A: The input address is not a valid address
B: The page is not in memory, and must be fetched from the disk
C: 1001 0001 1011 0011
D: 0001 1011 0011 1001
E: 0001 1011 1111 0011
F: 1001 0101 1011 1101
G: The physical frame number is not valid

Exercise 2:
Given the following logical/virtual address,
1001 1101 0011 0010
what is the corresponding physical address (see alternatives below)?

A: The page is not in memory, and must be fetched from the disk
B: The input address is not a valid address
C: 0001 1101 0011 0010
D: 1101 0011 0010 0001
E: 1001 1101 0011 1010
F: 0101 1111 0011 1010

G: The physical frame number is not valid

Exercise 3:
Given the following logical/virtual address,
0101 1001 0110 1101
what is the corresponding physical address (see alternatives below)?

A: The page is not in memory, and must be fetched from the disk
B: The input address is not valid
C: The physical frame number is not valid
D: 1111 1001 0110 1101
E: 1001 0110 1101 1111
F: 1000 1001 0110 1101
G: 1001 0110 1101 0001

Exercise 4:
Given the following logical/virtual address,
1100 1001 0010 1100
what is the corresponding physical address (see alternatives below)?

A: The page is not in memory, and must be fetched from the disk
B: 0101 1001 0010 1100
C: 1001 0010 1100 0101
D: 1000 1100 1001 1001
E: 1100 1001 0011 0001
F: The input address is not a valid address
G: The physical frame number is not valid

For each of the exercises above, select the correct answer alternative in the table below...

	A	B	C	D	E	F	G
Exercise 1	○	○	○	○	○	○	○
Exercise 2	○	○	○	○	○	○	○
Exercise 3	○	○	○	○	○	○	○
Exercise 4	○	○	○	○	○	○	○

Maximum marks: 8

4 Various multiple choice exercises

In each of the exercises below, you should select ONE correct answer.

Exercise 1:

Which of the following statements are correct with respect to disk scheduling?

A: Shortest seek time first (SSFT) may lead to starvation.

B: Circular SCAN (C-SCAN) is a bi-directional algorithm executing requests as the disk head moves both ways.

C: SCAN serves requests in a first-come-first-serve order as it scans the queue.

D: Preemptive scheduling algorithms are more efficient than non-preemptive algorithms.

E: If a process reads files sequentially, it does not matter which scheduling algorithm is used.

Exercise 2:

Which of the following items are **not true** about NTFS?

A: NTFS is a file system in Windows.

B: NTFS uses chaining-in-media to manage disk blocks

C: NTFS can store file data directly inside its metadata record in the master file table.

D: The master file table is a table of 1 KB records.

E: A "run" in NTFS is similar to "extents" in Unix file systems.

Exercise 3:

Which statement regarding the organisation of a process' memory is correct?

A: A program's instructions are stored in the *text/code segment*.

B: Dynamic memory (e.g., allocated with malloc) is stored on the stack.

C: A process does not have any memory organisation.

D: The *stack segment* has a fixed size.

E: A program's instructions are stored in the *data segment*.

Exercise 4:

A monolithic operating system kernel ...

A: ... is the part of the operating system that manages device drivers.

B: ... is the part of an operating system that handles monolithic files.

C: ... is the part of the operating system that handles interrupts.

D: ... has minimal functionality where other services are implemented in server processes running in user space.

E: ... is a kernel where all functionality is linked into a single object.

Exercise 5:

Which of these events invokes the CPU scheduler?

A: Function calls

B: Function termination

C: Process creation

D: Process termination

E: Process calling *execve()*

Exercise 6:

Which statement is true about process states?

A: When a process has spent its time on the CPU, the scheduler moves the process from "running" to "ready".

B: A process waiting for an external I/O operation is in the "ready" state.

C: A newly created process is initially placed in the "blocked" state.

D: When an external I/O operation finishes, the process is moved from "blocked" to "running".

E: If a process is waiting in the "ready" queue longer than a set threshold, the process is terminated.

For each of the exercises above, select the correct answer alternative in the table below...

	A	B	C	D	E
Exercise 1	○	○	○	○	○
Exercise 2	○	○	○	○	○
Exercise 3	○	○	○	○	○
Exercise 4	○	○	○	○	○
Exercise 5	○	○	○	○	○
Exercise 6	○	○	○	○	○

Maximum marks: 6

5 Page calculation

We have a system with 8-bit physical addresses and 10-bit virtual addresses. The system uses a two level page table where 3 bit is used to index the first page table, 3 bit indexes the second page table, and 4 bit is the offset into a page.

How many physical pages can fit in memory? ☐

How many virtual pages are there in the system? ☐

How large (in bytes) is a page? ☐

Maximum marks: 3

6 Various multiple choice exercises

In each of the exercises below, you should select ONE correct answer.

Exercise 1:

An access network is a network that ...

A: connects different countries

B: allows for faster access than a wireless network

C: controls access rights of network users

D: connects end systems to the Internet

E: none of the alternatives

Exercise 2:

With an ever growing link capacity, we get to

A: send more data per second, and thereby the time it takes for the first bit of a packet to arrive automatically becomes shorter

B: send the same amount of data per second, but the time it takes for the first bit of a packet to arrive becomes shorter

C: send more data per second, but the time it takes for the first bit of a packet to arrive stays approximately the same

D: choose whether we want to send more data per second, or reduce the time it takes for the first bit of a packet to arrive

E: send more data per second, but the time it takes for the first bit of a packet to arrive will increase because of the link load

Exercise 3:

Congestion control is necessary to avoid ...

A: bit errors

B: an overflow of the sender buffer

C: packet loss and increasing delay (packet delay)

D: collision between sender and receiver

E: an overflow of the receiver buffer

Exercise 4:

Which OSI layer is responsible for process-to-process delivery of complete messages?

A: session layer

B: application layer

C: presentation layer

D: transport layer

E: network layer

Exercise 5:

HTTP is stateless - this means that ...

A: applications that use the protocol do not need to remember (register) something from one transaction to the next

B: it works wherever the Internet is used and is not limited to a country, for example

C: it does not contain any control information in the data (payload)

D: there is no checksum

E: it can work over any underlying network technology

Exercise 6:

Which of the following addresses are needed to decide the next hop in a packet switched network?

A: destination address

B: tag id

C: source address

D: none

E: loop-back address

For each of the exercises above, select the correct answer alternative in the table below...

	A	B	C	D	E
Exercise 1	○	○	○	○	○
Exercise 2	○	○	○	○	○
Exercise 3	○	○	○	○	○
Exercise 4	○	○	○	○	○
Exercise 5	○	○	○	○	○
Exercise 6	○	○	○	○	○

Maximum marks: 6

7 Various multiple choice exercises

In each of the exercises below, you should select ONE correct answer.

Exercise 1:

Flow control is necessary to avoid ...

A: bit errors

B: an overflow of the sender buffer

C: collissions between the sender and receiver

D: an overflow of the receiver buffer

E: disturbance of the data flow on the link

F: that packets arrive in the wrong order

Exercise 2:

A switch forwards or filters a frame (packet) by comparing information in its address table with the frame's ...

A: layer 2 source address

B: layer 3 source address

C: layer 2 destination address

D: layer 3 destination address

E: port number

F: size

Exercise 3:

The Internet's network layer has been designed as a ... network

A: line switched

B: packet switched

C: unswitched

D: completely switched

E: partially line switched

F: none of the alternatives

Exercise 4:

Before data transmission begins, resources have to be reserved (allocated) for a ... network

A: line switched

B: packet switched

C: TCP based

D: UDP based

E: OSPF based

F: none of the alternatives

For each of the exercises above, select the correct answer alternative in the table below...

	A	B	C	D	E	F
Exercise 1	○	○	○	○	○	○
Exercise 2	○	○	○	○	○	○
Exercise 3	○	○	○	○	○	○
Exercise 4	○	○	○	○	○	○

Maximum marks: 4

8 Various multiple choice exercises

In each of the exercises below, you should select ONE correct answer.

Exercise 1:

In the Internet, congestion control is implemented in ...

A: Routers
B: Switches
C: TCP
D: UDP
E: IP
F: BGP
G: OSPF

Exercise 2:

For a given class B network 190.252.2.3, what is the network prefix?

A: 190.252.2.3
B: 190.252.2
C: 190.252
D: 190
E: 137
F: 55
G: none of the alternatives

Exercise 3:

Which protocol provides service guarantees (Quality of Service, QoS) regarding throughput, delay and successful packet transmission?

A: IP
B: UDP
C: TCP
D: BGP
E: OSPF
F: ARP
G: none of the alternatives

Exercise 4:

It is important to avoid misunderstandings between big vs. little endian because otherwise, it can happen that...

A: packets do not arrive at the receiver
B: the packet order changes
C: the byte order changes between the sending and receiving application
D: the wrong network interface is used
E: the checksum in the TCP header becomes wrong
F: the checksum in the IP header becomes wrong
G: none of the alternatives - it is not important

Exercise 5:

The transport layer is responsible for ... communication

A: router-to-router
B: switch-to-switch
C: network interface - to - network interface
D: IP-address - to - IP-address
E: end-to-end
F: cable-to-cable
G: city-to-city

For each of the exercises above, select the correct answer alternative in the table below...

	A	B	C	D	E	F	G
Exercise 1	○	○	○	○	○	○	○
Exercise 2	○	○	○	○	○	○	○
Exercise 3	○	○	○	○	○	○	○
Exercise 4	○	○	○	○	○	○	○
Exercise 5	○	○	○	○	○	○	○

Maximum marks: 5