

Answers and marking guide.

1.

Priority inversion is when a higher priority process is forced to wait for a resource held by a lower priority process. Explain how the problem can be solved without harm to any process and why the solution works.

[5 marks]

*The lower priority process has its priority **temporarily** raised to be equal to the priority of the highest priority process waiting for it to release its resource. They must mention temporarily to get full marks. This works because the process holding the resource will now take no longer to release it than the higher priority process would have, it also doesn't affect processes with an even higher priority.*

2.

Some file space allocation methods are suitable for direct access to data in files and some are suitable for sequential access to data in files. Describe a file allocation method that is suitable for sequential access but not suitable for direct access. Explain why it is not suitable for direct access.

[5 marks]

*Linked list allocation with each section pointing to the next section in the file. To move to any particular byte in the file the sections (or blocks) of the file need to be traversed in order. For direct access this could be a very large number of disk accesses in order to find the required information.*

3.

Briefly describe two ways of keeping track of free blocks on a disk device.

[6 marks]

Any two of:

*Linked list of free blocks. There is a pointer to the first free block. Each free block points to the next one.*

*Bitmap. A bitmap with each bit representing a block on the disk. A 1 (or zero) represents a free block.*

*Start points and lengths. An array (or list) of pointers to the starting point of a section of free blocks and the length of the section.*

*Any other method that seems reasonable.*

4.

This is a string of memory page references:

1, 2, 3, 4, 3, 2, 1, 5, 3, 2, 5

Draw diagrams showing the frame usage at each memory reference for each of the following page replacement algorithms. Also give the number of page faults generated by each algorithm. Assume the system uses pure demand paging and starts with no pages in real memory. There are **three** frames of real memory.

- FIFO – first in first out
- LRU – least recently used
- LFU – least frequently used (if the frequencies are the same use FIFO). A page gets its frequency set to one when it is loaded into a frame.

[9 marks]

Continued

Three marks each. If they make a mistake early on continue across and see if they get most of it right. Frame is the term the textbook uses for a page of real memory.

a) FIFO

page request	1	2	3	4	3	2	1	5	3	2	5
frame 0	1	1	1	4			4	4	3	3	
frame 1		2	2	2			1	1	1	2	
frame 2			3	3			3	5	5	5	

8 page faults.

b) LRU – least recently used

page request	1	2	3	4	3	2	1	5	3	2	5
frame 0	1	1	1	4			1	1	1	2	
frame 1		2	2	2			2	2	3	3	
frame 2			3	3			3	5	5	5	

8 page faults

c) LFU – least frequently used (if the number of accesses is the same use FIFO)

page request	1	2	3	4	3	2	1	5	3	2	5
frame 0	1	1	1	4			1	5			
frame 1		2	2	2			2	2			
frame 2			3	3			3	3			

6 page faults

5.

The textbook states “the Mach operating system has no file system per se.” In this case explain how an operating system built on top of Mach such as MacOS X can provide a file system to users. Mention any privileges that are needed to make the system work.

[5 marks]

The file system is built as a user-level server process. Requests are sent to the file service as messages via the kernel. All user level processes have the privileges to communicate with the file service. The file service itself has the privileges to communicate with the disk device interfaces.

6.

List eight file attributes that could be stored in a file system for each file in a typical multi-user operating system.

[8 marks]

name

location

file type

size

owner

group (on a Unix type system)

access information (either ACLs or bit permissions)

times – created, modified, accessed (these can count as three)

backed up bit

hidden bit

etc

7.

Describe the main steps a file system performs when a process opens a file.

[6 marks]

*They can get full marks if they have 4 of these. Not all OSs do all of them.*

- *searches for the file with that name*
- *verifies that the process has access rights to use the file in the way specified*
- *records the fact that the file is open (in the system-wide open file table) and which process is using it*
- *constructs an entry in the process open file table*
- *allocates a buffer for file data*
- *returns a pointer (file handle or file descriptor) to be used for future access*

8.

a) What are the four necessary conditions for deadlock?

[4 marks]

- *There is a circular list of processes each wanting a resource owned by another in the list.*
- *Resources cannot be shared.*
- *Only the owner can release the resource*
- *A process can hold a resource while requesting another.*

b) What is resource ordering and how does it prevent deadlock happening?

[2 marks]

*Resource ordering is only allowing resources to be collected by a process in a certain order. e.g. Memory must be allocated before files are open. It prevents deadlock by stopping cycles of processes waiting for resources.*

9.

In Unix a program with the setuid bit set is used to give the user running the program controlled access to the owner's permissions. Describe a security risk if such a program was left able to be written to by all users.

[3 marks]

*The file could be altered or replaced with a file to do anything to objects the owner had permissions over.*

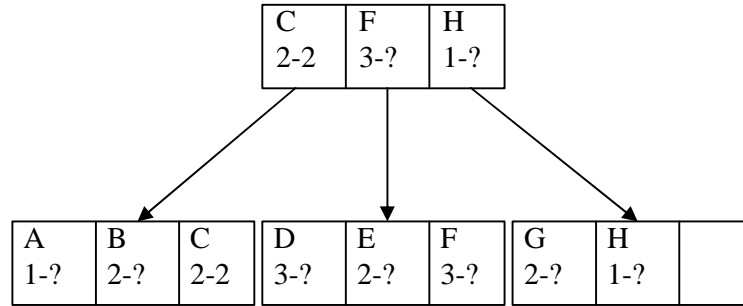
10.

This tree represents a file maintained over three revisions in a versioning file system as shown in lectures. What is the content of the file in each version?

The letters correspond to the following data:

- A: Operating Systems.
- B: The study of the systems that
- C: make computers usable:
- D: control computers, including
- E: file systems, process management,
- F: distributed operation,

- G: security and memory management.
- H: An essential part of a computing qualification.



[6 marks]

Version 1

*Operating Systems. An essential part of a computing qualification.*

Version 2

*Operating Systems. The study of the systems that make computers usable: file systems, process management, security and memory management. An essential part of a computing qualification.*

Version 3

*Operating Systems. The study of the systems that control computers, including file systems, process management, distributed operation, security and memory management. An essential part of a computing qualification.*

11.

What is migration transparency and what other form of transparency does it depend on?

[5 marks]

*Migration transparency means that objects such as files and processes can be moved around a distributed system without the programs or users being aware of the movement. In order to implement migration transparency the objects must have location transparency – which means their identifiers have no location information.*

12.

Distributed file systems use two different methods to provide file data – remote service or local caching. What advantages does a remote service distributed file system have over a caching system? What advantages does a caching distributed file system have over a remote service system?

[10 marks]

*Remote service*

- *simpler to implement because of no consistency problem*
- *uses less local memory (primary or secondary)*
- *matches local file access – e.g. a read call is turned into a real read of the file*

*Caching*

- *faster (in the general case) – less frequent use of the server, fast access to data when it is in the local cache*
- *more efficient*
- *scales better – the server is not the bottleneck in the same way*

13.

Two people are working on a project together. They each want the project files to be accessible from a directory called *project* in their own home directories. Describe two different ways this could be done. Also mention any advantages and disadvantages the two techniques have.

**[6 marks]***Any two of:**Two copies of the information*

- *changes to one are not seen by the other*

*Hard links*

- *changes to one are seen by the other*
- *if one is deleted the other still has access to the files*

*Soft links*

- *changes to one are seen by the other*
- *if the original is deleted the other has broken links*

*Any other plausible scheme*

14.

Some file systems allow files to be deleted while a process has the file open and is using it. The delete makes the file disappear from the directory structure but the data blocks are not released until the file is closed by the process that is using it. If the machine running the process was to crash after the file was deleted but before the file was closed then the data blocks would not be released but there would be no directory entry matching those blocks. Describe two methods to either deal with this problem or solve the problem. Which method do you prefer and why?

**[8 marks]***Two of:*

- *Checking the disk for unallocated blocks on startup.*
- *Flagging deleted files so that they don't appear to other processes but the system hasn't removed their directory entries until the blocks are released.*
- *Keeping a log of directory changes which can be checked on startup.*

*I prefer keeping a log, it is faster than the first method and keeps explicit track of changes.*

15.

Some operating systems, e.g. Unix, have a superuser who can modify almost all aspects of the system. Superusers pose an enormous security risk.

- a) Describe a different method that an operating system could use instead of having superusers.

**[6 marks]**

*Split the system into domains and have administrators for each domain, be very careful in determining the privileges required in each domain. There should be no control of another domain from inside each domain.*

- b) What disadvantages does this alternative method have when compared to the superuser system?

[3 marks]

*Less flexibility. Not as much power. Sometimes changes would need to be made in several different domains requiring different logins. Cross domain changes cannot easily be made.*

16.

We can use the Needham-Schroeder Protocol to enable two parties A and B to securely communicate with each other. First of all A asks the server S to provide it with a session key so that A can communicate with B. How does B know it can trust the message coming from A?

[3 marks]

*The session key is accompanied by a verifying message from S encrypted using B's secret key. B can decrypt this and check its contents. A cannot change this.*

---