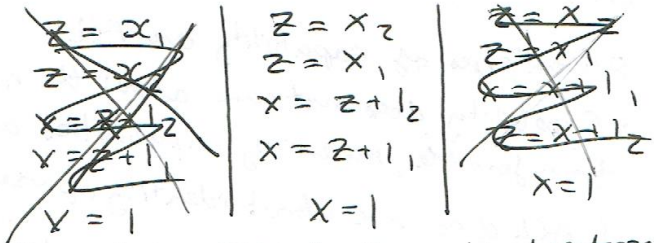
OS 2009-2010

1a) A process is an instance of a program that is being executed.

- Provide the illusion of concurrency
- Provide isolation - each process has own address space.
- Better utilisation of machine resources.

b)

$z = x_{(1)}$ $x = z+1_{(1)}$ $z = x_{(2)}$ $x = z+1_{(2)}$ $x = 2$	$z = x_{(2)}$ $x = z+1_{(2)}$ $z = x_{(1)}$ $x = z+1_{(1)}$ $x = 2$	$z = x_{(1)}$ $z = x_{(2)}$ $x = z+1_{(1)}$ $x = z+1_{(2)}$ $x = 1$	$z = x_{(2)}$ $z = x_{(1)}$ $x = z+1_{(1)}$ $x = z+1_{(2)}$ $x = 1$	$z = x_{(1)}$ $z = x_{(2)}$ $x = x+1_{(2)}$ $z = x+1_{(1)}$ $x = 1$



Above you can see all possible interleavings for the critical section of code. The subscript 1&2 denote the thread that is executing the code. Therefore the probability of 2 occuring is $^2/_6$ and the probability of 1 occuring is $^4/_6$.

c) Deadlock occurs if the following necessary and sufficient conditions hold simultaneously:

- Mutual exclusion: each resource is either available or assigned to exactly one process.
- Hold and wait: process can request resources while it holds other resources it acquired earlier.
- Non preemption: resources given to a process cannot be forcibly revoked
- Circular wait: two or more processes in a circular chain, each waiting for a resource held by the next process.

In this scenario the mutual exclusion condition is met since only 1 person can use a machine at a time. Hold and wait also occurs since there are 350 machines which means that once 87 students have reserved 4 machines each, there will be 2 left over, so the 88th student will reserve them and wait for another 2 to free up. Circular wait also occurs since there are more students than machines. The final condition, non-preemption, will determine if deadlock will occur. =>

If students can have access ~~her~~ to the machines for as long as they want (unlimited time) then deadlock will occur since all four conditions for deadlock as outlined above have been satisfied. However if students have a limited time to use the machines (i.e. preemption) then deadlock will not occur since the non-preemption condition is not met.

d) An access control list (ACL) is a list of permissions attached to an object. An ACL specifies which users or system processes are granted access to objects, as well as what operations are allowed on given objects.

A capability is a token which designates an object and gives the program the authority to perform a specific set of actions (owned/unique) on that object (much like a key to a safe)

Advantages of capability over ACL:
- Capability does not care about the identity of the user, since the token is transferable, meaning capabilities are flexible.
(ACL does care about identity of user, not flexible)

Advantage of ACL over capability:
- Harder to forge an authorised user since the ACL would need to be modified to.

2a) OS virtualisation refers to the use of software to allow system hardware to run multiple instances of different operating systems concurrently, on one computer system.

A hypervisor or virtual machine monitor (VMM) is a program which manages the access of multiple OS's to the underlying hardware.

b) i) A free block bitmap consists of an array of bits which indicate whether a particular block is free or not. 1 indicates not free, 0 indicates free.

The advantage of a bitmap over a list is that for a list additional memory is required to maintain a linked list, so a bitmap occupies less space in memory. A bitmap provides O(1) access time whereas a list O(n) since it has to be traversed. With a bitmap you also have fast deletion, since data needs not to be overwritten on delete, only the corresponding bit has to be flipped.

ii) The best-fit allocation policy searches for the ~~best space~~ most suitable space in memory which takes more time but leads to less memory space wastage as it has been optimally allocated.

The first-fit allocation policy simply places the item in the first available space which can accomodate the item. As a result it is faster than best-fit but wastes more memory.

The allocator places a process in the smallest block of unallocated memory in which it will fit.

iii) Best-fit

① 1001 1101 0001 1111 0000
② 1001 1101 1111 1111 0000
③ 00000000 1110 1111 0000
④ 1111 1000 1110 1111 0000

First-fit

① 1001 1101 0001 1111 0000
② 1001 1101 1111 1111 0000
③ 0000 0000 1110 1111 0000
④ 1111 1000 1110 1111 0000 (in this case they are the same)

c i) RAID 1 - mission critical but performance not an issue

ii) RAID 0 → not a mission critical process

iii) RAID 5 → mission critical & high performance needed.

not sure about these ...