CST Part IA: Operating System, SV 1
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1 2008P1Q2

(a) (i) $2^{15} + 2^{12} + 2^{10} + 2^{8} = 38144$
(ii) $-(2^{12} + 2^{10} + 2^{8}) = -5376$
(iii) $-Inverse((1001010100000000)_2 - 1) = -(0110101100000000)_2 = -27392$

(b) $C = 1$ Because $N + N > 2^{16} - 1$
$V = 1$ Because if we treat N as a signed value, add N to N will change the sign. (i.e. Adding two negative number gives a positive number.)

2 2011P2Q3

(a) (i) Access Control means the restriction to subjects of access to objects.
(ii) Access Control List is storing a list of subjects and rights with each objects.
(iii) Capacities are storing a list of objects and rights with each subjects.

3 2008P1Q8

(a) There are 5 process states: 1.Creation, 2.Ready, 3.Running, 4.Blocked, 5.Termination. Relation:1-2,2-3,3-2,3-4,3-5,4-2.

Creation
- System initialization.
- Execution of a process creation call by a running process.
- A subject(user)'s request to create a new process.
- Initiation of a batch job. (Automatically following another job)

Ready
- After creation or taken some events ready to run in CPU but waiting for other processes.
- Current process run for a long time, OS pause it for a while leave CPU for other process.

Running
- Using the CPU at that instant.

Blocked
- Unable to run until some external event happens.

Termination
- Finished execution, normal exit.
- Error exit. (e.g. unhandled exception)
- Fatal exit. (e.g. try to access privileged unit or fetch memory without rights)
- Killed by other process.

4 2007P1Q7

(a) Note $1024 * 1024 * 4096 = 2^{32}$.
So there is a bijection between set of all 32-bit virtual address and set of all bytes in the memory.

From the most to the least significant bit in the virtual address, assume following virtual memory address structure.
P1 = first 10 bits. P2 = following 10 bits. Offset = the last 12 bits.
The MMU first uses P1 to index into the first-level page table and obtain entry P1 which corresponding to a second-level page table. The MMU then use P2 to index into this second-level page table and obtain entry P2 which should be corresponding to some memory chunk with length 4096 bytes. If the Present/Absent bit is false then this is causing a page fault. Otherwise the page is in the memory, the page frame number is taken from the second-level page table is combined with Offset to construct the physical address which will be put on bus and send to memory.

(b) -

Present bit Whether the entry is a map to a valid physical address.

Read bit Whether the process has the right to read the physical address mapped to.

Write bit Whether the process has the right to write the physical address mapped to.

Execute bit Whether the process has the right to execute the physical address mapped to.

(c) The paging address is one dimensional which goes from 0 to some maximum address.
The segmentation can have two or more segments which have separated virtual address spaces.
This can be implemented by restructuring the virtual address.
Segment number - Page number - Offset
The MMU will first map segment number to some page table (segment).
Then it maps the page number to a physical address in that page table.
After checking protection bits, the physical address will be sent to memory on the bus.