**Part I: Virtual Memory Questions**

1. The virtual address 11123456 converted to binary form is:

0001 0001 0001 0010 0011 0100 0101 0110

Provided that the page size is 4096 bytes = 212, and virtual-memory space of 232 bytes, the page table size will be 212/232 = 220 bytes, therefore there will be 20 bits for the page number. As a result, the first 20 bits (0001 0001 0001 0010 0011) will be the page number, and the remaining last 12 bits (0100 0101 0110) will be the displacement added to the frame address used to obtain the physical address. The determination of the page number and displacement in the virtual address is done in the hardware and so is the rest of the process, all operations are done in the hardware.

1. Given P is the fraction of memory accesses that cause a page fault and MA is the normal memory access time, effective access time (EAT) is:

All times will be provided in nanoseconds.

EAT = (1-P) MA + P\*(page fault service time) = 200

EAT = (1-P) \* (100) + P \* (100 + (1-0.7) \* (8 000 000) + (0.7) \*(20 000 000))

= 100 – 100P + P \* (16 400 100)

200 = 100 – 100P + 16 400 100P

P = (100) / (16 400 000) = **0.0000060975**