

Assignment 3

CISC324 – Fall 2021

Due Nov 27, 2021, at 11:59 PM.

Question 1: (5 Points)

Assuming a byte-addressed memory, give the size of the memory for the following address sizes.
Size = 2^M

For $M=11$ the size is 2048 B
For $M=25$ the size is 32 MB
For $M=36$ the size is 64 GB
For $M=44$ the size is 16 TB
For $M=27$ the size is 128 MB

Question 2: (10 Points)

Consider a computer in which the virtual memory consists of 8 pages of 1024 bytes each, mapped onto physical memory of 32 page frames. Then, assuming that the memory is byte-addressed, how many bits are there in a virtual address? How many bits are there in the physical address?

For logical address, bits = (num of pages) * (page size) = ($2^3 * 2^{10}$) = 2^{13} therefore num of bits in logical address = 13

For physical address, bits = (num of frames) * (frame size) = ($2^5 * 2^{10}$) = 2^{15} therefore num of bits in physical address = 15

Question 3: (12 Points)

The following sequence of virtual memory references is generated when a program is executed. Each memory reference is a 12 bits number written as three hexadecimal digits.

0x019, 0x01A, 0x1E4, 0x170, 0x073, 0x30E, 0x185, 0x24B, 0x24C, 0x430, 0x458, 0x364

- (a) What is the reference string, assuming a page size of 256 Bytes? The definition of reference strings is given at the end of textbook section 9.4.1.

0, 0, 1, 1, 0, 3, 1, 2, 2, 4, 4, 3 which becomes 0, 1, 0, 3, 1, 2, 4, 3

- (b) Find the page fault rate for the reference string in part (a): assume that 2 frames of main memory are available to the program and the FIFO page replacement algorithm is used. Note that the page fault rate is calculated as “number of page faults” divided by “number of virtual memory references used to form the reference string”.

0 (fault, mem = {0, _}), 1 (fault, mem = {0, 1}), 0 (hit, mem = {0, 1}), 3 (fault, mem = {3, 1}), 1 (hit, mem = {3, 1}), 2 (fault, mem = {3, 2}), 4 (fault, mem = {4, 2}), 3 (fault, mem = {4, 3})

We have 6 page faults on 12 references, meaning we get a rate of $6/12 = 50\%$

(c) Repeat (b) using the LRU (Least Recently Used) page replacement algorithm.

0 (fault, mem = {0, _}), 1 (fault, mem = {0, 1}), 0 (hit, mem = {0, 1}), 3 (fault, mem = {0, 3}), 1 (fault, mem = {1, 3}), 2 (fault, mem = {1, 2}), 4 (fault, mem = {4, 2}), 3 (fault, mem = {4, 3})

We have 7 page faults on 12 references, meaning we get a rate of $7/12 = 58.3\%$

(d) Repeat (b) using the optimal page replacement algorithm.

0 (fault, mem = {0, _}), 1 (fault, mem = {0, 1}), 0 (hit, mem = {0, 1}), 3 (fault, mem = {3, 1}), 1 (hit, mem = {3, 1}), 2 (fault, mem = {3, 2}), 4 (fault, mem = {3, 4}), 3 (hit, mem = {3, 4})

We have 5 page faults on 12 references, meaning we get a rate of $5/12 = 41.67\%$

Question 4: (3 Points)

Consider a main memory with 220 nanoseconds raw access time, and a TLB (Translation Look-aside Buffer) cache with 120 nanoseconds respectively. Knowing that the TLB hit ratio is 98%, calculate the effective access time

$$(0.98 * (120 + 220)) + ((1 - 0.98) * (120 + (2 * 220))) = 344.4\text{ns}$$

How to Submit:

Write your answers to the given questions in a file and name it according to this format 324-1234 –Assn3.pdf, where 1234 stands for your last 4 digits of your students ID. Notice the extension is “pdf” it is preferred to submit a pdf file. If you can not save your file as pdf then you may save it as a document.

Then upload “423-1234 –Assn3.pdf into Assignment 3 dropbox on onQ. You may upload several times if you wish , however, onQ only keeps the last uploaded file. Please check your files after uploading.

An “*I uploaded the wrong file*” excuse will result in a mark of zero, no exceptions please!

Also note that last uploaded file always replaces previous file, and onQ is set to have only the last uploaded file.