Date 12/11/22

Assignment - Main Memory

8.20 Assuming a 1-KB page size, what are the page numbers and offsets for the following address references (provided as decimal numbers):

a. 3085
b. 42095
c. 215201
d. 650000
e. 2000001

Ans The given page size is equal to 1 KB.
$1 KB = 1024$ bytes $= 2^{10}$ bytes
Nothing is given therefore it means that the addressable are byte addressable.
No. of bits reserved for the page offset is 10.
This means a total of 10 LBS will be used to refer to the page offset. Now,

(a) 3085
In binary, 3085 = 110000001101
The LSB 10 bits are the page offset and the rest 2 bits are the page number. In decimal, the page number is 3 and the page offset is 13.

(b) 42095
In binary, 42095 = 1010010001101111
The LSB 10 bits are the page offset and the rest 6 bits are regular page numbers. In decimal, the page number is 41 and the page offset is 111.

(c) 215201
In binary, 215201 = 110100100010100001

The LSB 10 bits are the page offset and the rest 8 bits are the page number. In decimal, the page number is 207 and the page offset is 161.

(d) 650000

In binary, 650000 = 10011110101100010000

The LSB 10 bits are the page offset and the rest 10 bits are the page number. In decimal, the page number is 634 and the page offset is 784.

(e) 2000001

In binary, 2000001 = 111101000010010000001

The LSB 10 bits are the page offset and the rest 11 bits are the page number. In decimal, the page number is 1953 and the page offset is 129.

8.23 Consider a logical address space of 256 pages with a 4-KB page size, mapped onto a physical memory of 64 frames.

(a) How many bits are required in the logical address?

Ans Logical address size $= 2^m$ [$\because$ m = no. of bits in logical addresses]

Logical address size = No. of pages × page size

$= 256 \times 4$ KB [$\because$ 1 KB = 1024 bytes]

$= 256 \times 4096$

$= 1048576 = 2^{20}$

$\therefore$ m = 20 bit Ans

(b) How many bits are required in the physical address?

Ans Let x be the no. of bits in physical addresses.

Physical address size $= 2^x$

= No. of frames × frame size

$= 64 \times 4$ KB

$= 64 \times 4096 = 2^6 \times 2^{12} = 2^{18}$

∴ No. of required bits in the physical address is x, i.e 18 bits Ans

8.24 Consider a computer system with a 32-bit logical address and 4-KB page size. The system supports up to 512 MB of physical memory. How many entries are there in each of the following?

Ans A conventional single-level page table:
No. of pages = No. of single entries = ?

Size of logical address space = 2^m = No. of pages × page size

$\Rightarrow 2^{32}$ = No. of pages × 2^{12}

$\Rightarrow$ No. of pages = $\frac{2^{32}}{2^{12}} = 2^{20}$ pages Ans

8.25 Consider a paging system with the page table stored in memory.

(a.) If a memory reference takes 50 nanoseconds, how long does a paged memory reference take?

Ans Here, we have two memory addresses → total 100 nanoseconds required.
50 nanoseconds to access the page table & 50 nanoseconds to access the word in memory.
∴ 50 × 2 = 100 nanoseconds.

(b) If we add TLBs, and 75 percent of all page-table references are found in the TLBs, what is the effective memory reference time? (Assume that finding a page-table entry in the TLBs takes 2 nanoseconds, if the entry is present).

Ans Effective Access Time = P × hit memory time + (1 − P) × miss memory time

If we fail to find the page number in the TLB, then we must first access memory for the page table and frame number (100 nanoseconds).

Hit happens 75% of the time and a miss happens 25% of the time, then the

∴ Effective Access Time = 75% × hit memory time + 25% × TLB miss time

$= 0.75 \times (50\,ns + 2\,ns) + 0.25 \times (100\,ns + 2\,ns)$

$= 64.5\,ns.$ Ans

8.28. Consider the following segment table:

Segment	Base	Length
0	219	600
1	2300	14
2	90	100
3	1327	580
4	1952	96

What are the physical addresses for the following logical addresses?

(a) 0, 430 (b) 1, 10 (c) 2, 500

(d) 3, 400 (e) 4, 112

Ans (a) 0, 430

⇒ 219 + 430 = 649

(b) 1, 10

2300 + 10 = 2310

(c) 2, 500

Illegal address since size of segment 2 is 100 and the offset in logical address is 500.

(d) 3, 400

1327 + 400 = 1727

(e) 4, 112

Illegal address since size of segment 4 is 96 and the offset in logical address is 112.