

## SHEET Number 2

Solve the following problems.

1. Suppose a process page table contains the entries shown below. Using the format shown in Figure 6.22a, indicate where the process pages are in memory.

Valid Bit	Frame
0	--
1	3
0	--
0	--
1	2
1	0
0	--
1	1

2. Suppose we have  $2^{10}$  bytes of virtual memory and  $2^8$  bytes of physical main memory. Suppose the page size is  $2^4$  bytes.

- How many pages are there in virtual memory?
- How many page frames are there in main memory?
- How many entries are in the page table for a process that uses all of virtual memory?

3. You have a byte-addressable virtual memory system with a two-entry TLB, a 2-way set associative cache and a page table for a process P. Assume cache blocks of 8 bytes and page size of 16 bytes. In the system below, main memory is divided up into blocks, where each block is represented by a letter. Two blocks equal one frame.

Page	Frame
0	3
4	1

TLB

	TAG	DATA	TAG	DATA
Set 0	I	01	C	00
Set 1	H	10	D	00

Cache

	Valid	Frame
0	1	3
1	1	0
2	0	-
3	1	2
4	1	1
5	0	-
6	0	-
7	0	-

Page Table

Frame	Block
0 {	C
	D
1 {	I
	J
2 {	G
	H
3 {	A
	B

Main Memory

Page	Block
0 {	A
	B
1 {	C
	D
2 {	E
	F
3 {	G
	H
4 {	I
	J
5 {	K
	L
6 {	M
	N
7 {	O
	P

Virtual Memory  
For Process P

Given the system state as depicted above, answer the following questions:

- a) How many bits are in a virtual address for process P? Explain.
- b) How many bits are in a physical address? Explain.
- c) Show the address format for virtual address 0x12 (specify field name and size) that would be used by the system to translate to a physical address and then translate this virtual address into the corresponding physical address. (Hint: convert the address to its binary equivalent and divide it into the appropriate fields.) Explain how these fields are used to translate to the corresponding physical address.
- d) Given virtual address 0x06 converts to physical address 0x36. Show the format for a physical address (specify the field names and sizes) that is used to determine the cache location for this address. Explain how to use this format to determine where physical address 0x36 would be in cache. (Hint: convert 0x36 to binary and divide it into the appropriate fields.)
- e) Given virtual address 0x19 is located on virtual page 1, offset 9. Indicate exactly how this address would be translated to its corresponding physical address and how the data would be accessed. Include in your explanation how the TLB, page table, cache and memory are used.

4. Does a TLB miss always indicate that a page is missing from memory? Explain.