

CMSC 311 Fall, 2006

Virtual Memory Worksheet

RTFP

**Problem 1. (16 points):**

The following problem concerns the way virtual addresses are translated into physical addresses.

- The memory is byte addressable.
- Memory accesses are to 4-byte words.
- Virtual addresses are 20 bits wide.
- Physical addresses are 16 bits wide.
- The page size is 4096 bytes.
- The TLB is 4-way set associative with 16 total entries.

In the following tables, **all numbers are given in hexadecimal**. The contents of the TLB and the page table for the first 32 pages are as follows:

TLB			
Index	Tag	PPN	Valid
0	03	B	1
	07	6	0
	28	3	1
	01	F	0
1	31	0	1
	12	3	0
	07	E	1
	0B	1	1
2	2A	A	0
	11	1	0
	1F	8	1
	07	5	1
3	07	3	1
	3F	F	0
	10	D	0
	32	0	0

Page Table					
VPN	PPN	Valid	VPN	PPN	Valid
00	7	1	10	6	0
01	8	1	11	7	0
02	9	1	12	8	0
03	A	1	13	3	0
04	6	0	14	D	0
05	3	0	15	B	0
06	1	0	16	9	0
07	8	0	17	6	0
08	2	0	18	C	1
09	3	0	19	4	1
0A	1	1	1A	F	0
0B	6	1	1B	2	1
0C	A	1	1C	0	0
0D	D	0	1D	E	1
0E	E	0	1E	5	1
0F	D	1	1F	3	1

**Part 1** The Basics (8pts)

1. The box below shows the format of a virtual address. Indicate (by labeling the diagram) the fields (if they exist) that would be used to determine the following: (If a field doesn't exist, don't draw it on the diagram.)

- VPO* The virtual page offset
- VPN* The virtual page number
- TLBI* The TLB index
- TLBT* The TLB tag

19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0



2. The box below shows the format of a physical address. Indicate (by labeling the diagram) the fields that would be used to determine the following:

- PPO* The physical page offset
- PPN* The physical page number

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0



**Part 2 Translation**

For the given virtual addresses, indicate the TLB entry accessed and the physical address. Indicate whether the TLB misses and whether a page fault occurs.

If there is a page fault, enter “-” for “PPN” and leave part C blank.

**Virtual address:** 2DA49

- Virtual address format (one bit per box)

19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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- Address translation

Parameter	Value
VPN	0x
TLB Index	0x
TLB Tag	0x
TLB Hit? (Y/N)	
Page Fault? (Y/N)	
PPN	0x

- Physical address format (one bit per box)

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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**Virtual address:** 1F1F8

- Virtual address format (one bit per box)

19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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- Address translation

Parameter	Value
VPN	0x
TLB Index	0x
TLB Tag	0x
TLB Hit? (Y/N)	
Page Fault? (Y/N)	
PPN	0x

- Physical address format (one bit per box)

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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