Problem Set #3

Date Assigned: Friday, March 11, 2016
Date Due: Friday, March 18, 2016
Points: 50 pts

1. (16 pts) A computer has a main memory of 128K words where one word is equal to one byte. The computer contains a cache that is 32 bytes, with 4 lines of 8 words each (not including the tag). The cache mapping function is direct mapping. The tags in the cache are:

Cache line number	Tag	Contents
0	100111100011	N/A
1	001010111100	N/A
2	111101011001	N/A
3	111011001000	N/A

Answer the following questions and show all work.

a. (2 pts) How many bits is a main memory address?

b. (2 pts) How many blocks are there in main memory?

c. (6 pts) Show the format of the main memory address? I want to see the fields and the size of each field.

d. For each of the main memory addresses listed in the table, answer the following:

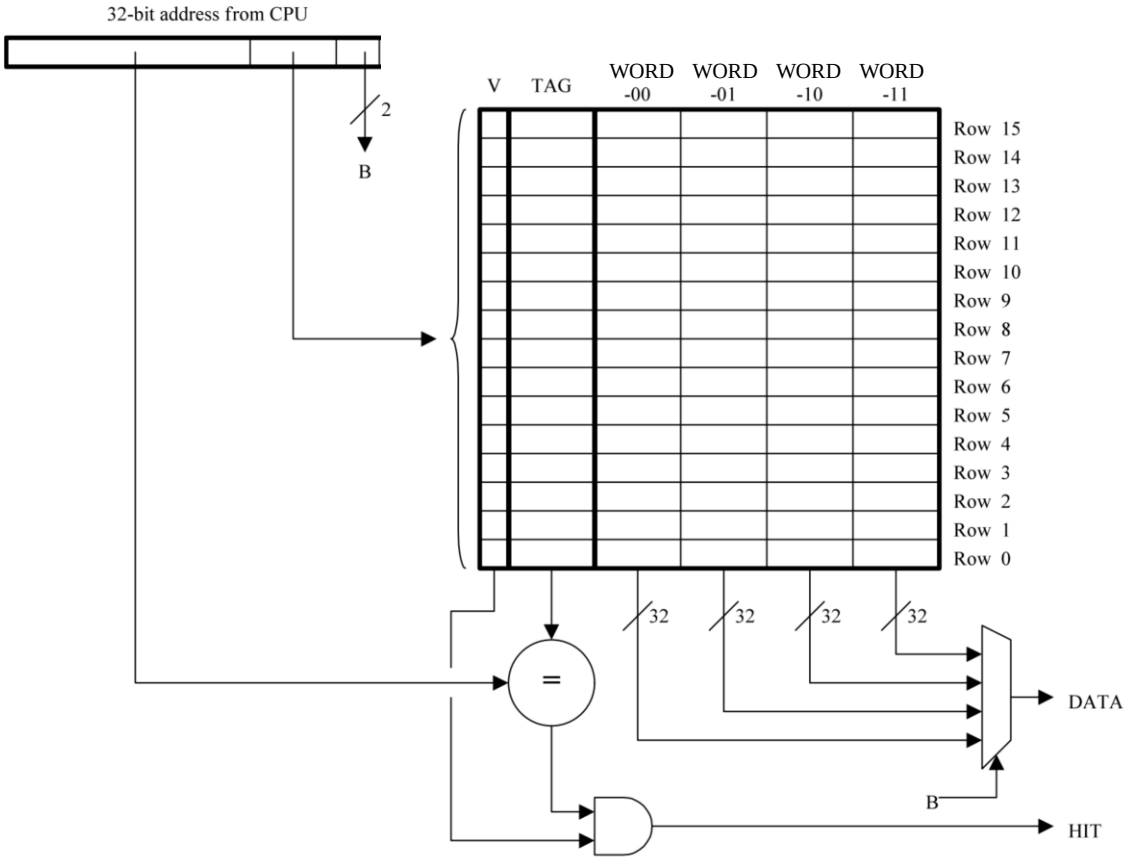
i. (2 pts) What cache line is the memory address mapped to?

ii. (2 pts) What word slot is the memory address mapped to?

iii. (2 pts) Is the memory address currently in the cache?

Memory Address	Cache Line (decimal)	Word Slot (decimal)	Currently in Cache?
0x026C4			
0x1D91A			
0x0508F			
0x13C64			

2. (20 pts) A computer contains a direct-mapped cache as shown in the diagram below. Each word is 32 bits, each memory address is 32 bits, and each line size is 4 words (not counting the tag and v).



Answer the following questions, clearly showing all work.

a. (2 pts) What are the maximum number words from main memory that can be stored in the cache at any one time?

b. (2 pts) How many bits of the memory address are used to select which line of the cache is accessed?

c. (2 pts) How many bits wide is the tag field?

d. (3 pts) Explain the purpose of the one-bit V field associated with each cache line. This is also called the **dirty** bit or **use** bit.

e. Assume that memory location 0x3328C was present in the cache. Answer the following:
   i. (2 pts) In what cache location would we find the data from that memory location? Use the row and column labels from the above diagram to identify cache line and word.

   ii. (2 pts) What is the value of the tag field (in hex) for the cache row in which the data appears?

f. (4 pts) Can data from locations 0x12368 and 0x322F68 be present in the cache at the same time? What about data from locations 0x2536038 and 0x10F4? Explain.

g. (3 pts) In a cache miss, how many words need to be fetched from memory to fill the appropriate cache location?

3. (14 pts) A computer has a main memory containing 64K blocks, where each block is 64 bytes. There also exists a 2-way set-associative cache consisting of 4 sets. Answer the following questions, showing all work.

    a. (2 pts) How many lines are in the cache?

    b. (2 pts) How many bits are in a memory address?

    c. (6 pts) Show the format of the memory address. Include the fields as well as their sizes.

    d. (4 pts) Which sets do the following memory addresses map to:

        i. 0xB4E7

        ii. 0x2A4E2B

How to turn in your solution:

- Please make sure your problem sets are typed, answered in order, and stapled together. Number all of your answers. Name your word document 03punet.docx.

- A hard copy of your Problem Set Solution is due on the instructor's desk by 9:15am on the day the assignment is due.

- Drop the 03punet.docx file into the CS 430 drop folder on Grace by the deadline.