CSC 230: Introduction to Computer Architecture (Spring 2019)

Assignment 3

Due before 23:55pm, Mar 20, 2019

Important Notes

There are 5 questions, and the total score is 90. Submit the answer for Questions 1 to 3 in PDF file, submit the "*asm" source file for Question 4 and 5.

Questions 1-4 can be done by a group of two students, but Question 5 must be finished separately.

Prior to submitting your assignment, you should familiarize yourself with the University Policy on Academic Integrity. We will use a plagiarism detection tool on all assignment submissions.

Question 1

Suppose in a hypothetical computer, the main memory contains 8 blocks, denoted by alphabetic characters A - H according to the order of their addresses. The cache contains 4 lines, numbered as 0, 1, 2 and 3.

To design the cache mapping mechanism and cache replacement algorithm, we use a special program for test. The sequence of memory access (to the blocks) for this program is as:

$$A\ D\ D\ C\ C\ B\ A\ B\ E\ F$$
$$A\ A\ D\ D\ C\ F\ A\ C\ D\ D$$
$$E\ H\ B\ B\ D\ B\ E\ C\ B\ B$$
$$E\ D\ B\ B\ D\ G\ H\ D\ B\ C$$

If this system use direct mapping, we know that blocks A and E in the main memory are mapped to line 0 in the cache, blocks B and F to line 1, blocks C

and G to line 2, and blocks D and H to line 3.

Follow the idea in Example 4.5.7, please using the following chart to analyze the cache usage (i.e, marking a cache replacement with the alphabetic block number, and marking a hit with '+'). Then, calculate the hit ratio if choose direct mapping [5].

	A	D	D	C	C	B	A	B	E	F	A	A	D	D	C	F	A	C	D	D
0																				
1																				
2																				
3																				

	E	H	B	B	D	B	E	C	B	B	E	D	B	B	D	G	H	D	B	C
0																				
1																				
2																				
3																				

Question 2

For this same computer system, if choose associative mapping. Please construct the similar diagram as Question 1 to calculate the hit ratio for the following block replacement strategies.

(1) LRU (Least Recent Used). [5]

(2) First-in-first-out (FIFO). [5]

(3) Least Frequently Used (LFU). [5]

Question 3

Again, for the same computer system, if choose 2-way set associative mapping. Please construct the similar diagram as Question 1 and 2 to calculate the hit ratio for the following block replacement strategies: (1) LRU [5]; (2) FIFO [5]; (3) LFU [5].

(4) What's the design decision after comparing the results of Question 1 to 3. [5]

Question 4

Besides 1's complement and 2's complement, another way of representing signed values in binary is **signed magnitude**. In this representation, the MSB (most significant bit) is used to represent the sign (with 0 indicating a non-negative number and 1 indicating a negative number) and have the remaining bits correspond to an unsigned value (or magnitude).For example, we have:

$$-5 = (10000101)_2$$
$$5 = (00000101)_2$$
$$-100 = (11100100)_2$$
$$100 = (01100100)_2$$

Please write a function to transform a signed value represented in signed magnitude into zero-ending string (of decimal integer) based on the template "q4.asm". Name your code as "**itoa.asm**" for submission. [20].

Question 5

On the LCD Shield device, The LCD screen has two lines (numbered as 0 and 1), each with 16 columns (numbered from 0 to 15). To write message into the LCD for display, we need to include three driver files: *lcd_function_code.asm*, *lcd_function_defs.inc* and *LCDdefs.inc*[1].

Continue with your code for Question 5 in Assignment 2, write a program to repeatedly update the content on LCD while illuminating LEDs randomly (according to the random number generated) with an interval as approximately 1 second. For example, the following picture shows the content of the LCD when the random number generated for controllign LEDs is 5 and 55, respectively.
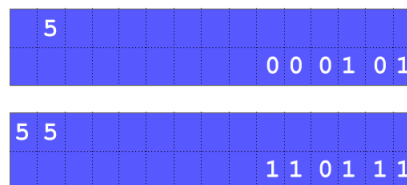
Take the attached file "q5.asm" (as well as the LCD driver files) as a template, write the code for all the functions to implement this application. Name your code file as "**rlcd_VNum.asm**" for submission where "*VNum*" stands for your V-number. [30]

---

[1]These driver files are a little different to the ones used in lab. They are adapted to suit for this question.