**CS 465 – Fall 2021– Homework 4 - Corrected**

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Team Allowed: maximum of two per team. The members of a team must be from the **same** CS 465 section.

State clearly the team member names and GMU IDs as comments in each page of the submitted report.

IMPORTANT:

1. Start to work on the homework early.
2. If you plan to do the homework with a classmate, make a determination early if your teammate is responsive.
3. Type your answers in the Word file and generate a pdf file from it for submission.
4. **Do not share your solutions or partial solutions** on Piazza or any other platforms (electronic or otherwise) before the deadline. This assignment is individual to a group. If you want to ask questions about your solution, please ask the TA or me.
5. **Plagiarism is not permitted in any form. We enforce the university policy and honor code**

**Late submissions are not accepted.**

Use a Word processor to type your answers and generate a PDF file to submit your homework.

**How to submit:** The submission will be made via a blackboard link available to you. You must submit a PDF file answering all questions. For team projects, only one member of the team should submit the PDF file and the other should submit a one-page PDF file stating the names of both members of the team. If you fail to submit the one-page PDF file you will not get any credit for the homework.

The PDF file name should follow the following convention: "cs465\_hw4\_LastName1\_LastName2"(for 2-member teams), or "cs465\_hw4\_LastName1" (for 1-member teams).

Manually simulate the behavior of a cache under four different organizations: direct-mapped, 2-way set associative, 4-way set associative, and fully associative. The cache can hold 8 blocks. Consider that the following block reference string is used for each of the four cache organizations. The numbers below represent the memory block numbers of the reference string in the order generated.

 0, 5, 8, 0, 8, 7, 6, 8, 6, 4, 15, 14, 13, 14, 8, 0

Fill out the tables below for each cache organization. The first column indicates the block number in the block reference string. The next column indicates the cache index or set number where the referenced block should go. The third column shows the computation you used to obtain the value in the second column. The fourth column indicates whether the block reference generated a miss or hit. Finally, the last column should indicate “Cold cache” or “Contention” in the case of misses. Cold cache means that a miss occurs because the block was never referenced before. Contention means that a block has already been referenced before but was evicted from the cache due to contention with another block that competes for the same cache location or set. Use LRU as replacement policy when needed.

**a) Direct Mapped Cache [25 points]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Block # | Cache index | Computation | Miss or Hit | Miss reason (Cold cache or Contention) |
| 0 |  |  |  |  |
| 5 |  |  |  |  |
| 8 |  |  |  |  |
| 0 |  |  |  |  |
| 8 |  |  |  |  |
| 7 |  |  |  |  |
| 6 |  |  |  |  |
| 8 |  |  |  |  |
| 6 |  |  |  |  |
| 4 |  |  |  |  |
| 15 |  |  |  |  |
| 14 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |
| 8 |  |  |  |  |
| 0 |  |  |  |  |

Complete the table below with the final state of the cache.

|  |  |
| --- | --- |
| Cache index | Block number |
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |

What was the cache hit rate?

Answer:

**b) 2-way set associative [25 points]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Block # | set # | Computation | Miss/Hit | Miss reason (Cold cache or Contention) |
| 0 |  |  |  |  |
| 5 |  |  |  |  |
| 8 |  |  |  |  |
| 0 |  |  |  |  |
| 8 |  |  |  |  |
| 7 |  |  |  |  |
| 6 |  |  |  |  |
| 8 |  |  |  |  |
| 6 |  |  |  |  |
| 4 |  |  |  |  |
| 15 |  |  |  |  |
| 14 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |
| 8 |  |  |  |  |
| 0 |  |  |  |  |

Complete the table below with the final state of the cache.

|  |  |
| --- | --- |
| Set # | Block numbers |
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |

What was the cache hit rate?

Answer:

**c) 4-way set associative [25 points]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Block # | set # | Computation | Miss or Hit | Miss reason (Cold cache or Contention) |
| 0 |  |  |  |  |
| 5 |  |  |  |  |
| 8 |  |  |  |  |
| 0 |  |  |  |  |
| 8 |  |  |  |  |
| 7 |  |  |  |  |
| 6 |  |  |  |  |
| 8 |  |  |  |  |
| 6 |  |  |  |  |
| 4 |  |  |  |  |
| 15 |  |  |  |  |
| 14 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |
| 8 |  |  |  |  |
| 0 |  |  |  |  |

Complete the table below with the final state of the cache.

|  |  |
| --- | --- |
| Set # | Block numbers |
| 0 |  |
| 1 |  |

What was the cache hit rate?

Answer:

**d) fully associative [25 points]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Block # | set # | Computation | Miss/Hit | Miss reason (Cold cache or Contention) |
| 0 |  |  |  |  |
| 5 |  |  |  |  |
| 8 |  |  |  |  |
| 0 |  |  |  |  |
| 8 |  |  |  |  |
| 7 |  |  |  |  |
| 6 |  |  |  |  |
| 8 |  |  |  |  |
| 6 |  |  |  |  |
| 4 |  |  |  |  |
| 15 |  |  |  |  |
| 14 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |
| 8 |  |  |  |  |
| 0 |  |  |  |  |

Which blocks are in the cache after all blocks were referenced?

Answer:

What was the cache hit rate?

Answer: