

## CS 31 Homework 9: Paging and Virtual Memory (due Tuesday December 6, 2022)

Names and lab sections:

**\*\* NOTE: This homework assignment is 3 pages long. \*\***

### Question 1

For each of the following assembly instructions, indicate whether the instruction **could** cause a page fault, whether it **could** cause a cache miss, and whether it **could** cause the dirty bit in the cache to be set to 1.

(a) `mov x1, 7`

Page fault? YES or NO | Cache miss? YES or NO | Dirty bit? YES or NO

(b) `str x1, [x2]`

Page fault? YES or NO | Cache miss? YES or NO | Dirty bit? YES or NO

(c) `ldr x5, [x7, 24]`

Page fault? YES or NO | Cache miss? YES or NO | Dirty bit? YES or NO

(d) `add x0, x6`

Page fault? YES or NO | Cache miss? YES or NO | Dirty bit? YES or NO

For the next three questions you will be tracing memory accesses in a system with the following architecture:

- 8-bit virtual addresses
- 4 frames of physical RAM
- 16-byte page/frame size

## Question 2

How many bytes of data can a single process store in:

- (a) physical memory                      (b) virtual memory

## Question 3

For each the given virtual addresses, divide the address into the **page number** and **page offset**.

1 0 0 0 1 0 1 0

1 0 0 0 1 1 1 1

1 0 1 0 1 0 1 0

## Question 4

On the accompanying Page Table diagram, show the results of the following memory operations on RAM and the Page Table. Assume first-in-first-out replacement (FIFO). Within each box, time should progress downward, so the first address loaded appears at the top and subsequent changes are written below. To the right of the table, label each change with number of the operation that caused it. Annotate each operation below with *hit* or *page fault* to indicate whether the data was found in physical memory. Don't forget to update the valid bits!

1. read 0 0 0 1 1 0 1 0

6. write 0 0 0 0 1 0 0 1

2. write 0 0 0 1 1 0 1 1

7. read 0 0 0 0 0 0 0 0

3. read 1 1 1 1 1 0 0 0

8. read 0 1 0 1 0 1 1 1

4. read 1 1 1 1 1 0 1 0

9. write 0 0 0 1 1 0 1 0

5. read 0 1 1 0 1 0 0 0

10. read 0 0 0 1 1 1 0 1

Page Table

index	V	frame	notes
0	0		
1	0		
...	...	...	
5	0		
6	0		
...	...	...	
15	0		