CMPU 334 Quiz1

Fall 2021

Name: _____

Instructions:

This is a closed book, closed notes exam. No electronic devices, including calculators, are allowed. You have 75 minutes. There are 7 problems and 11 pages to this exam.

Good Luck!

1 (15)	
2 (13)	
3 (17)	
4 (10)	
5 (18)	
6 (15)	
7 (12)	
Total (100)	

1. (15 points) Limited Direct Execution

Order the steps(1 to 6) in the execution of a system call, with 1 being the first step and 6 being the last step.

____ jump to trap handler

____ trap into the OS

____ return to process

____ move to user mode

____ move into kernel mode

____ return from trap handler

What role does the hardware timer play in helping to provide a Limited Direct Execution environment for processes?

2. (13 points) Processes

1. Say we have a system with the following three process states:

- Running
- Ready
- Blocked

Which of the following are valid process transitions? **Circle all that apply.**

A. BLOCKED to RUNNING

B. BLOCKED to READY

C. RUNNING to READY

D. RUNNING to BLOCKED

E. READY to RUNNING

F. READY to BLOCKED

2. Which of the following would be considered the state of a process? **Circle all that apply.**

A. Process Memory

B. Register Values

C. State of the TLB

D. Open files

3. In Linux, a process that has finished running but the parent hasn't called wait on the child is called what? **Circle One.**

A. An orphan process

B. A zombie process

C. A blocked process

D. An init process

3. (17 points) Scheduling

1. If you were most concerned about **fairness**, which scheduler would you pick? **Circle One.**

   A. First In, First Out
   B. Shortest Job First
   C. Shortest Time-to-Completion First
   D. Round Robin

2. If you were most concerned about **turnaround time**, which scheduler would you pick? **Circle One.**

   A. First In, First Out
   B. Shortest Time-to-Completion First
   C. Round Robin
   D. Linux CFS scheduler

3. If you were most concerned about **response time**, which scheduler would you pick? **Circle One.**

   A. First In, First Out
   B. Shortest Job First
   C. Shortest Time-to-Completion First
   D. Round Robin

4. In a Multi-Level Feedback Queue, adding a priority boost solves which of the following problems? **Circle all that apply.**

   A. Prevention of gaming the system by requesting I/O at the end of your time slice
   B. Potential starvation of processes
   C. Prioritizing a CPU-bound job that has now become interactive
   D. Letting a CPU-bound job have a longer time quantum

5. In the Linux CFS scheduler, which of the following statements are **true**? **Circle all that apply.**

   A. It is always fair for processes over the target scheduling latency.
   B. Users can control the priority of a process to give it a higher share of the CPU
   C. To speed up scheduling, CFS keeps track of only running or runnable processes in a linked list.
   D. CFS decides which process to run next based on its virtual runtime (vruntime).

4. (15 points) Memory

1. Which of the following statements about `malloc()` are **true**? **Circle all that apply.**

   A. `malloc` returns -1 if it can not fulfill the request

   B. `malloc` takes a single argument specifying the number of bytes of requested memory

   C. `malloc` returns the actual number of bytes you were allocated

   D. `malloc` returns a pointer to the start of the memory that was allocated

2. Which of the following statements about `free()` are **true**? **Circle all that apply.**

   A. `free` takes a pointer previously returned by malloc

   B. `free` will return an error if you free the same pointer twice

   C. Using `free` is recommended but not strictly necessary because C will garbage collect any memory that is no longer in use

   D. When a process exits, allocated memory will be reclaimed by the OS even if `free` was not called

3. Which of the following statements about segments are **true**? **Circle all that apply.**

   A. Bounds checking can only be done in the the virtual address space

   B. Bounds checking can only be done in the the physical address space

   C. Bounds checking can be done in either the virtual or physical address space

   D. A system that uses segments can suffer from external fragmentation

4. Which of the following statements about the binary buddy allocator are true? **Circle all that apply.**

   A. Requests can suffer from internal fragmentation

   B. Coalescing free blocks is simple

   C. It takes O(n) time to find a free block

5. (12 points) Odds and Ends

1. Which of the following are **policies. Circle all that apply.**

A. Walking a page table to find a PFN

B. Finding a free block with First Fit

C. Reducing the priority of a process after it has used up its time quanta

D. Limited direct execution

2. Which of the following help to speed up address translation**. Circle all that apply.**

A. TLB

B. Having a multi-level page table

C. Having base and bounds registers for segments

D. Marking the stack as non-executable

3. Which of the following statements about the clock algorithm are **true**? **Circle all that apply.**

A. Needs hardware support to be efficiently implemented

B. Approximates an LRU algorithm

C. Used in the Linux CFS scheduler

D. May not terminate with certain memory access patterns

4. Which of the following statements about the VAX/VMS virtual memory system are **true**? **Circle all that apply.**

A. It is an example of a hybrid system

B. Used bounds registers because of the very large page size used in the system

C. Utilized the lazy optimization copy on write (COW)

D. Had only one segment to facilitate data transfer between user space and the kernel

6. (10 points) Page Tables

Assume the following: a 22-bit virtual address space, with a 1024 byte (1 KB) page size.

(a) How many bits are in the **offset** portion of the virtual address?

(b) How many bits are in the **VPN** portion of the virtual address?

Now, let's focus on the page table. Assume each *page table entry* is 4 bytes in size. Assuming a *linear* page table:

(c) How many page table entries (PTEs) are there in the page table?

(d) How many PTEs fit onto a single page in this system?

(e) How many **pages** of memory do we need to hold the entire page table?

7. (18 points) Address Translation

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

- The memory is byte addressable.
- Virtual addresses are 16 bits wide.
- Physical addresses are 14 bits wide.
- The page size is 512 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**	**PFN**	**Valid**
0	14	08	1
	1F	1F	1
	1A	0A	0
	19	09	1
1	18	1E	0
	17	13	1
	02	01	0
	11	18	0
2	06	17	0
	1C	02	1
	1A	05	1
	1D	16	1
3	1F	14	0
	0E	0B	0
	18	14	1
	10	10	0

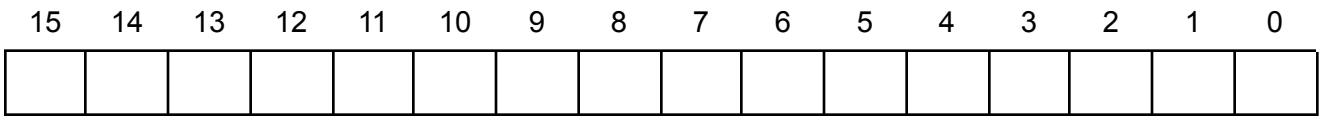
Page Table (first 32 pages only)					
VPN	**PFN**	**Valid**	**VPN**	**PFN**	**Valid**
00	1B	1	10	16	0
01	06	0	11	17	0
02	03	1	12	16	1
03	1F	0	13	03	0
04	00	1	14	1D	0
05	13	0	15	1B	0
06	1E	1	16	09	0
07	11	1	17	06	0
08	1A	0	18	0C	1
09	01	1	19	14	1
0A	08	1	1A	0F	0
0B	05	1	1B	12	1
0C	16	1	1C	10	0
0D	1F	0	1D	17	1
0E	1D	0	1E	19	1
0F	10	0	1F	0A	1

For the given virtual address, 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 “N/A” for “PFN” and leave part (c) blank.

Virtual address : **`0x15A8`**

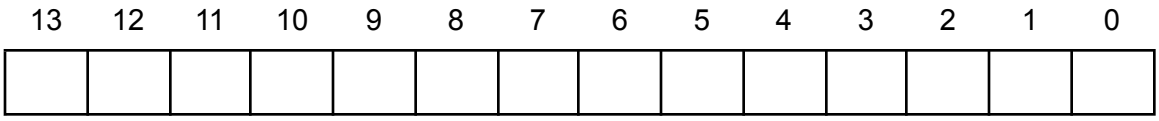
(a) Virtual address format (one bit per box)



(b) Address translation

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

(c) Physical address format (one bit per box)



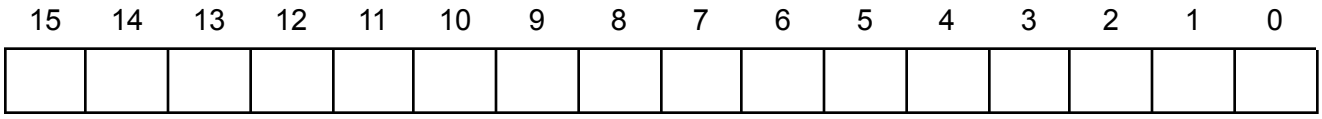
Physical address: 0x_____

For the given virtual address, 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 “N/A” for “PFN” and leave part (c) blank.

Virtual address : **`0xBA93`**

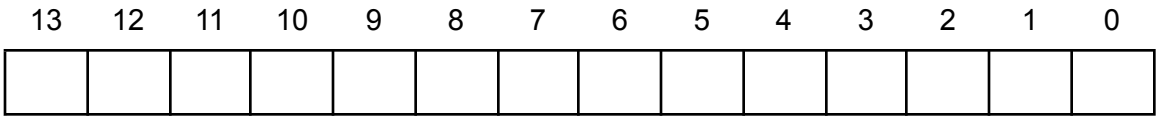
(b) Virtual address format (one bit per box)



(c) Address translation

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

(d) Physical address format (one bit per box)



Physical address: 0x_____