CSSE 332 -- Operating Systems

Paging

Name: _____

Question 1. (5 points) What is the main feature of paging that allows us to avoid external fragmentation?

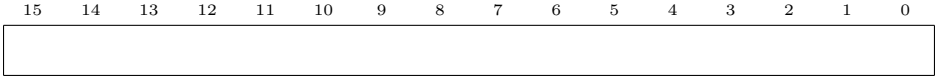
Question 2. (5 points) In a paged memory architecture, memory is divided into equal sized chunks. In virtual space, those chunks are called _____, while in physical space, they are called _____. To make address translation possible, each process needs to maintain a _____, which is an array of _____.

Question 3. The following questions assume a 16-bit architecture, which means that all of our addresses are 16 bits wide.

(a) (5 points) If we would like to design our paging system to have **1KB** pages. How many bits should we reserve from the 16-bits address for the page offset?

(b) (5 points) In that case, how many pages can each process have?

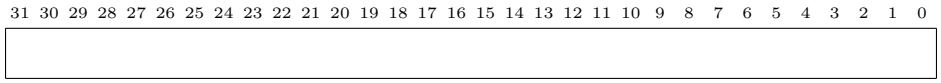
(c) (5 points) In this bit-box below, show how the page number and the page offset are represented.



(d) (5 points) Write down the formula used to translate a virtual address (`VA`) into a physical address (`PA`).

(e) (5 points) Assume that each PTE is 16 bits, what is the size of a page table (in bytes)?

Question 4. (5 points) Assume now that we are working with a 32-bits RISC-V architecture. Describe the content of a page table entry (PTE) in the bit box below.



Question 5. (5 points) Describe the meaning of the permission bits in RISC-V below.

1. `PTE_V`: _____
2. `PTE_W`: _____
3. `PTE_R`: _____
4. `PTE_X`: _____
5. `PTE_U`: _____

Question 6. Answer the following question about the `xv6` operating system.

(a) (5 points) Given a process represented by a `struct proc` pointer `p`. You can use _____ to access `p`'s page table in the kernel.

(b) (5 points) When in kernel space executing on behalf of a user process (e.g., on a system call), you can use the _____ function to access the current running **user** process.

(c) (5 points) The function _____ can be used to fetch a physical frame number given a virtual address. The lower _____ bits of the returned physical frame number will always be _____.

Question 7. (5 points) Describe some of the shortcomings of the discussed paging approach.

Question 8. (10 points) Please write down two **sentences** describing two new things that you learned in this session.

Question 9. (10 points) Please write down two things that you are still not very clear about, or any questions that you might have that the session did not go over or did not cover well.