Final Exam for CSE 153 (Fall 2017)

15th *December 2017* **Name:**

Student ID:

Instructions:

***** This exam is out of a total of 20 points.

***** Be brief in your answers. You will be graded for correctness, not on the length of your answers.

* Make sure to write legibly. Incomprehensible writing will be assumed to be incorrect.

* Read all questions carefully. Every word is in there for a reason.

I. Indicate whether any 10 of the following statements are true or false (**5 points**)

_____ Segmentation can lead to internal fragmentation

_____ Swap can be smaller than physical memory

_____ Swap resides on disk

_____ Page tables can be bigger than physical memory

_____ Page faults are handled by hardware

_____ Journaling FS improve the performance of FFS

_____ Page replacement can require invalidating a TLB entry

_____ Multi-level page tables improve the performance of address translation

_____ The working set of a process includes all its data pages

_____ free () does not need a system call

_____ Explicit free list is better than implicit free list for heap management

II. (**5 points**) Consider a memory system with a virtual address space of 32 bits, a physical address space of size 30 bits, and a page size of 4Kbytes.

a. (1 point) Given the virtual address 0xff0beef, what is the value of the VPN and the offset?

VPN:

Offset:

b. (1 point) Given two pointers (i.e., virtual addresses) VA and VB with values 0xff00423 and 0xff01321 respectively, which of the following is true about their physical addresses. Assume that both pages are in memory.

    a. VA's physical address is larger than VB's physical address
    b. VB's physical address is larger than VA's physical address
    c. It depends on whether we have a TLB hit or miss
    d. Its impossible to tell

c. (1 point) Consider now the following two addresses PA and PB with values 0xff00423 and 0xff00321 respectively.

    a. VA's physical address is larger than VB's physical address
    b. VB's physical address is larger than VA's physical address
    c. It depends on whether we have a TLB hit or miss
    d. Its impossible to tell

d. (1 point) Can the virtual address of a global array change over the lifetime of a program (without the program copying/moving it)? Can the physical address?

e. (1 point) Someone argues that the clock algorithm is supposed to be an approximation of LRU – Take a position for or against this statement, and briefly justify it.

III. (**5 points**) In the following problem, consider a unix file system with i-nodes similar to the one we discussed in class. It has 8 direct links, 1 indirect link, 1 double indirect link and 1 triple indirect link. The block size is 1 Kbyte. Assume a pointer is 4 bytes in size.

(a) (1 point) What is the maximum file size that does not use the triple indirect link in inode?

(b) (1 point) Suppose that you write one more block worth of data at the end of the file in part (a), how many additional blocks will be needed and the new structure of the file

(c) (1 point) How many blocks total on the disk will have to be updated to carry out the operation in part (b). Note that some other blocks not related directly to the file may have to be updated.

(d) (2 points) Your computer crashes in the middle of the operations above; explain what could cause the disk to be inconsistent? Show a specific scenario with the operations in part c and explain what is the observed effect of the inconsistency.

IV (5 + 1 bonus point) Consider a byte-addressable system with 1 Gbyte physical memory that uses a 2-level page table. The directory (i.e., outer page table) has a size of 16Kbytes. The PTE size is 8 bytes. Its ok to leave expressions if they are too difficult to simplify.

(a) (1 point) What is the size of the inner page table ***in pages***? (Hint: you can infer this from the directory size)

(b) (1 points) If the page size is p bytes, what is the number of PTEs in the inner page table as a function of p (Hint: use the result you derived in part (a)).

(c) (1.5 points) Given also that the Virtual addresses are 36 bits wide, write another expression for the number of PTEs in the inner page table as a function of the page size, p.

(d) (.5 and 1 point bonus) Given that the expressions in (b) and (c) are both for the the number of PTEs in the inner page table, solve for p to determine the page size in the system

(e) (1 point) How many bits are there in the Physical Page number?