**CS 241 Fall 2013**

**Midterm Exam Study Guide**

**C Programming**

1. What is POSIX?
2. Explain the difference between a library function and a system call.
3. Give an example of a POSIX system call used in CS241 lectures or reading.
4. How does pointer arithmetic work?
5. What is the \* operator? What does it do? What is the & operator? What does it do?
6. How do you define a function pointer?
7. What is a String? What is NULL?
8. What is the difference between strlen() and sizeof()?
9. What’s the difference between a stack and a heap variable? What about global and static variables?
10. When is a stack full?
11. How does malloc() and free() work?
12. What is the difference between a string and a string literal?
13. How do strcpy(), strcat(), and strncat() work?

**Memory**

1. What is the difference between physical and virtual memory?
2. What is a page fault?
3. What operations occur for every page fault? What operations occur only for some page faults?
4. What are the different memory allocation selection algorithms and what are the advantages of each?
5. How are virtual addresses translated to physical addresses in multi-level page tables? Given a virtual address and the physical page number, can you write code to translate the virtual address to a physical address?
6. How do page size and the number of levels of page tables affect the number of entries in a page table?
7. What is a page table entry? What is contained in each PTE?
8. What is the purpose of the Present (P), Dirty (D), Read-Write (RW), Not Execute (NX), and Accessed (A) bits?
9. What are the page eviction algorithms?
10. What is the difference between internal and external fragmentation?
11. What are the different page replacement policies and the advantages of each?
12. Describe how the buddy system works and the run time for different operations.
13. What is thrashing? When does it occur?
14. What causes a SEGFAULT and what happens when one occurs?
15. When is a process swapped out to disk?
16. Name three benefits of virtual memory (as opposed to allowing programs to directly access physical memory).
17. Name one advantage of segmentation over paging, and one advantage of paging over segmentation.
18. Assuming a 32-bit address space and 4 KB pages, what is the virtual page # and offset for virtual address 0xd34f6a5?
19. Give an example of a page fault that is an error, and an example of a page fault that is not an error.
20. Suppose we have a 64-bit address space and 16 KB pages. How big is the page table of a single process? What is the problem here? How would multi-level page tables help solve this problem?
21. Which scheme is better: OPT or LRU? Why?
22. How does the virtual memory subsystem know the exact location where a particular page is stored on disk, if it is swapped out of memory?
23. Compare and contrast (give one benefit and one disadvantage) for: implicit, explicit, segregated, and buddy free lists.

**Threads and Processes**

1. Which resources are shared between threads of the same process? Which are not shared?
2. Write a simple program using pthread\_create(). What is the possible output of your code?
3. X is a global variable and initially X = 0. What are the possible values for X after two threads both try to increment X?
4. What happens when a thread calls exit()?
5. What happens to a process’s resources when it terminates normally?
6. Describe what happens when a process calls fork().
7. Under what conditions would a process exit?
8. Explain the actions needed to perform a process context switch.
9. Explain the actions needed to perform a thread context switch.
10. Compare the use of fork() to the use of pthread\_create().
11. In a multiprocessor system, what conditions will cause threads within a process to block?
12. Explain how a process can become orphaned and what the OS does with it. How about zombies?
13. Describe how to use the POSIX call wait().
14. Explain what happens when a process calls exec().
15. Why are some functions not thread safe?
16. If a process spawns a number of threads, in what order will these threads run?
17. Explain how to use pthread\_join() and why it is used.
18. Explain how a shell process can execute a different program.
19. Explain how one process can wait on the return value of another process.
20. Describe the transitions between running, ready and blocked in the 5 state model.

**Semaphores / Mutexes**

1. When do you have to use a semaphore or mutex?
2. What is mutual exclusion?
3. How can use use a mutex lock to ensure that concurrent code operates correctly?
4. What is critical section?
5. What are the critical section requirements?
6. Briefly describe software-based and hardware-based mutual exclusion mechanisms?
7. Write a sample program to initialize a mutex, lock a shared variable, enter the critical section and unlock the mutex.
8. How do you destroy a mutex?
9. Write a sample program to demonstrate that threads conflict in practice?