CMPSC 311 Alternate Exam 2

April 13, 2015

Closed book, closed neighbor, no electronic tools or additional papers.
You may not share or discuss exam questions with anyone.
1 Short Questions (33pts total, 3pts each, be brief)

1. What is the difference between `calloc` and `malloc`?

2. What is the term for I/O functionality which always returns immediately, regardless of whether there is data available or not?

3. Fill in the blank in the output of the following code:

   ```c
   int16_t x = 10;
   int16_t *a = &x;
   int16_t *b = a + 4;
   printf("%p\n\n", a);  // a = 0x7fff5c40
   printf("%p\n\n", b);
   ```

4. When debugging a stack smashing bug, what type of variable is most likely to be the cause of the problem?

5. In terms of entries in a process’s page table, what is a segmentation fault?

6. The binary value 1111000011001010 is stored in memory on a big-endian machine. If the same bytes, in the same order, were interpreted by a little-endian machine, what value would they represent? (You may answer in binary.)
7. What does the following shell command do?

`tee a.txt < b.txt | sort > c.txt`

8. What is the term for a bug in which the pointer to dynamically allocated memory is lost?

9. What standard C function checks the value of `errno` and prints a nicely formatted error message to the standard error stream?

10. What is the name of the kernel data structure that stores information about all of the open files in the system?

11. What is an anonymous memory mapping?

2 Medium Questions (27pts total)

12. (5pts) What is the output from the following shell script?

```bash
#!/bin/bash
true && echo one
echo two || echo three
false || echo four
echo five && false
echo six && echo seven
```
13. *(5pts)* Explain the difference between the GDB commands `next`, `step`, and `finish`.

14. *(5pts)* Identify the problem with the following function, and explain what would need to be changed to fix this problem.

```c
// Returns a newly-allocated copy of the string "str"
char *copy_string(char *str)
{
    int len = strlen(str);
    char *new = malloc(len);
    int i;
    for (i = 0; i < len; i++)
        new[i] = str[i];
    return new;
}
```

15. *(6pts)* If a file has the octal mode 0774, what rights does this grant and to which users/groups?
16. *(6pts)* Write an implementation of the `strncpy` function.

3  **Long Questions (40pts total, 10pts each)**

17. Write a C function that takes a 4-byte unsigned integer and returns the highest number of consecutive 1s in its binary representation. For example, given the integer 29, which is 11101 in binary, this function would return 3, and given the integer 94, which is 1011110 in binary, it would return 4.
18. Write a C function `read_ten` that takes an array of integers as a parameter. This function should read ten integers from the ASCII text file “ints.txt” and store them in the array. You may assume that the file contains at least ten integers and no other data, and that the array has space for at least ten elements.

19. You are given a 32-bit binary number `x`. For each of the following descriptions, complete the one-statement C assignment using bitwise operators to accomplish the task:

   (a) Set bit 5 of `x` to 1 and store the result in `a`.

   ```c
   uint32_t a =
   ```

   (b) Clear bit 5 of `x` (i.e., set it to 0) and store the result in `b`.

   ```c
   uint32_t b =
   ```

   (c) Toggle bit 5 of `x` and store the result in `c`.

   ```c
   uint32_t c =
   ```

   (d) Extract the field found in bits 5–10 of `x` (as in a TipTap instruction) and store the result in `d`.

   ```c
   uint32_t d =
   ```
20. Fill out the following two box-and-arrow diagrams to describe the state of the program at Point A and Point B labeled in the code below. Be sure to include the values of any integers (for a pointer the arrow is sufficient).

```c
uint32_t x[3] = {1, 2, 3};
uint32_t *p = x;
uint32_t **p2p = &p;
// Point A

*p += 1;
*p2p += 1;
p += 1;
**p2p += 1;
// Point B
```

Note that the positive direction in these diagrams is up.