

IC221: Systems Programming

6-Week Written Exam

February 12, 2014

Answer the questions in the spaces provided on the question sheets. If you run out of room for an answer, continue on the back of the page. Show all work, but please be legible.
Microscopic writing will not be graded. **This is a closed exam. No additional material may be used to complete this exam.**

Name: _____

Alpha: _____

| Question | Points | Score |
|----------|--------|-------|
| 1 | 15 | |
| 2 | 15 | |
| 3 | 15 | |
| 4 | 15 | |
| 5 | 15 | |
| Total: | 75 | |

1. For the following questions, assume a file system with the following structure. All directories end in `/`, all files have no set file extension, and `~` is the home directory.

```
~/
|
|--> foo/
|   |____.-> bar.txt
|   |____.-> foo
|
|--> bar/
|   |____.-> bar.jpg
|   |____.-> foo
|   |____.-> baz/
|
|----> baz/
```

- (a) [3 points] What is the output of running `ls` from the home directory?

- (b) [3 points] What is the output of running the command `ls -a bar` from the home directory?

- (c) [3 points] Write a glob pattern that will list, with `ls`, all files that start with `bar`. Assume that the `ls` is run from the home directory.

- (d) [3 points] Write a `find` command that will find all directories and print them to the terminal. Assume that the `find` is run from the home directory.

- (e) [3 points] Write a `find` command with an `xargs` or `-exec` that will remove all files (*not* directories) named `foo`.

2. For this question, assume you have a comma separate file (`database.csv`) with the following fields:

```
First Name,Last Name,Street Address,City,State,Phone Number
```

The state, is a two-character postal code (e.g. MD for Maryland and CA for California). The phone number is always formatted like 999-999-9999. The `database.csv` is not corrupted, and none of the fields may have a comma in it.

- (a) **[3 points]** Write a command line to count the number of unique states in `database.csv`. Your command may contain pipes and redirects.

- (b) **[3 points]** Write a command line to extract all the area codes of each of each of the phone numbers in `database.csv`. It is fine if the same area code is printed multiple times. Your command may contain pipes and redirects.

- (c) **[3 points]** Write a command line that will save all lines in `database.csv` that contain the state code "MD", for Maryland, anywhere on a database line. Then save those lines to a file named `database.md.csv`. Your command may contain pipes and redirects.

- (d) **[3 points]** What are the three guiding principles of the Unix design philosophy?

- (e) **[3 points]** Using an answer from above, describe how that command meets the Unix design philosophy.

3. The questions below all reference this small program:

```
1 int main(){
2     int fd, n;
3     char buf[4096];
4
5     if( (fd = open("save.out", O_WRONLY | O_TRUNC | O_CREAT, 0644)) < 0){
6         fprintf(stderr, "ERROR: Cannot Open File\n");
7         return 2; //error!
8     }
9
10    while( (n = read(0, buf, 4096)) > 0 ){
11        if ( write(fd, buf, n) < 0 ){
12            fprintf(stderr, "ERROR: Bad Write\n");
13            return 2; //error!
14        }
15    }
16
17    if( n < 0 ){
18        fprintf(stderr, "ERROR: Invalid Read\n");
19        return 2;
20    }
21
22    close(fd);
23    return 0;
24 }
```

- (a) [4 points] In the code above, place a **circle** around all *library functions* and a **box** around all *system calls*. What is the purpose of a system call with respect to the user interaction with the operating system?

- (b) [3 points] In the `open()` function call on Line 5, use the following option flags: `O_WRONLY`, `O_TRUNC`, `O_CREAT`. Describe in plain English what each of these flags mean and the method that is being used to combine them.

- (c) [4 points] What are the file descriptor numbers and names for each of the standard file descriptors? Which of those are being used in the above program?

- (d) [4 points] What does the above program do?

4. The questions below all reference the following bash script, `foobar_existence.sh`:

```
1 #!/bin/bash
2
3 for arg in $*
4 do
5     if [ $arg == "foo" ]
6     then
7         echo "You say foo, I say bar"
8     else
9         ls $arg >/dev/null 2>&1
10        res=$?
11
12        if [ $res -eq 0 ]
13        then
14            echo "$arg exists"
15        else
16            echo "$arg DOES NOT exist"
17        fi
18    fi
19 done
```

- (a) [3 points] On line 1, there is a special kind of comment to start the bash script. What does this comment do with respect to running the script in the terminal like, `./foobar_existence.sh`?

- (b) [3 points] What values do the special bash variables `$*` and `$?` store? Refer to the script to explain.

- (c) [4 points] On line 9, there is a sequence of redirects with the `ls` command. What standard file descriptors are redirected where?

- (d) [5 points] Using the directory structure from Question 1, what is the output of running `foobar_existence.sh` from the home directory with the following arguments: `foo bar/foo xyzz bar/bar.jpg`.

5. Consider the following C code:

```
1  typedef struct{
2      int left;
3      int right;
4  } pair_t;
5
6  int main(){
7      pair_t pair_array[4];
8      pair_t * p;
9      int i;
10
11     for( i=0; i<4; i++){
12         pair_array[i].left = i;
13         pair_array[i].right = i*2;
14     }
15
16     p = pair_array+2; /* MARK */
17
18     printf( "A: (%d,%d)\n", p->left, p->right);
19
20     printf( "B: (%d,%d)\n", p[1].left, p[1].right);
21
22     return 0;
23 }
```

(a) [4 points] Draw the stack/memory diagram for the above code at the MARK.



(b) [4 points] What is the output of this program?



(c) [4 points] What is the difference between the `.` and the `->` operators when accessing structure members? Use the above code in your explanation.



(d) [3 points] Does any memory need to be de-allocated in this program? If so, what? And, if not, why not?

