

CS146 Midterm

1. A "process tree" is a tree defined in the natural way for processes: each node (other than the root) has a unique parent (which is the process that forked it), and a process can have any number of children (including zero), that it forks. Assume that "init" forks and execs a "getty" process. The "getty" then execs a "login", which (once somebody logs in and types their password) execs "/bin/bash". Assume that the user then runs a shell script from their login shell's command line. The shell script is called "lsw", is executable, and contains the following text:

```
#!/bin/sh
(ls | sort) | wc
```

Assume that there are no other processes in the entire system than those mentioned in this question. Draw the entire process tree that exists on the system while the second line of the shell script is executing. (Assume that when a pipeline is formed, all processes in the pipeline are forked by the shell under which the pipeline executes.)

2. I'm logged into the machine called "igor". Here's some info about a file called "foo" that's there:

```
igor:~$ ls -l foo
-rwx----- 1 wayne    faculty    10 Feb 12 21:47 foo
igor:~$ cat ./foo
#!/bin/wc
igor:~$ ./foo
```

The last line above shows me executing "foo". Will there be any output? If so, what will it be? If not, why not?

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3. Describe the difference in the output of the following two commands. In particular, describe which file descriptors are dup'd to which, to which file descriptor the output ultimately goes, and whether it appears on the terminal or disappears into /dev/null.

```
echo hello 1>&2 >/dev/null
```

```
echo hello >/dev/null 1>&2
```

4. Here is a short C program called "foo.c":

```
static int i;  
int j;  
extern int k;  
void f(int x) { return 2*x;}  
int main(void) { int z = f(2); exit(0); }
```

a) List each variable in "foo.c" along with whether, at run time, that variable will be stored on the stack, or the heap.

b) If I type "gcc -c foo.c", what's the name of the file produced?

c) List all names that will appear in the symbol table, and whether each has storage allocated in the object file. (You don't need to worry about the values they will take on, just list their names, and then "yes" or "no", depending upon whether storage is allocated or not.)