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Operating Systems
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OS 2019 Quiz Sheet #2

Problem 2.1: *semaphores* (2+1 = 3 points)

a) Define the semaphore operations `up` and `down`.

b) Which special property do the `up` and `down` operations have?

Problem 2.2: *process creation using* `fork()` (6+1 = 7 points)

Consider the following C program. Assume that all system calls succeed at runtime, that no other processes are created during the execution of the program, and that process identifiers are allocated sequentially.

```c
#include <stdio.h>
#include <unistd.h>

static int x = 0;

int main(int argc, char *argv[])
{
    pid_t p = getpid();

    x++;
    fork();
    if (! fork()) {
        if (fork()) {
            x++;
        }
        x++;
    }

    printf("p%d: x = %d\n", getpid() - p, x);
    sleep(60);
    return 0;
}
```

a) How many processes does the program create during its execution. Draw the process tree.

b) What is the output produced by the program?