CS 4323 Design and Implementation of Operating Systems I

Assignment 01: Full Marks 100

Due Date: 02/11/2024, 11:59 PM CT **End Date: 02/11/2024, 11:59 PM CT**

- This assignment needs to be done individually and it should be computer typed, not handwritten.
- Please read the submission guidelines carefully before you start the assignment.
- Make sure to run the program multiple times to ensure the correctness of your answer.

Note: To run the codes, you need to add appropriate header(s).

1. Consider the following snippet of code in C:

```c
int main(){
    fork();
    fork() && fork() || fork();
    fork();
    return 0;
}
```

Based on the above code snippet and considering none of the fork() calls in the parent and the child process fail, answer the following:

a) How many processes are created by this program? Explain in detail the logic behind your answer. **[2 + 8 Marks]**

b) Verify your answer in part(a) by adding appropriate *printf* statement(s) in the above code. Your program must compile without any error or warning in the CSX server. **[2 Marks]**

c) Draw the process tree diagram with **[5 Marks]**

i) clearly specifying which node belongs to which fork in the code snippet. **[2 Marks]**

ii) For the nodes which do not produce a child node, briefly specify the reason for not having any child node. **[3 Marks]**

2. Consider the following snippet of code in C:

```c
int main(){
    fork();
    fork() || fork() && fork();
    fork();
    return 0;
}
```

Based on the above code snippet and considering none of the fork() calls in the parent and the child process fail, answer the following:

a) How many processes are created by this program? Explain in detail the logic behind your answer. **[2 + 8 Marks]**

b) Verify your answer in part(a) by adding appropriate *printf* statement(s) in the above code. Your program must compile without any error or warning in the CSX server. **[2 Marks]**

c) Draw the process tree diagram with **[5 Marks]**
   i) clearly specifying which node belongs to which fork in the code snippet. **[2 Marks]**
   ii) For the nodes which do not produce a child node, briefly specify the reason for not having any child node. **[3 Marks]**

3. Consider the following snippet of code in C:

```
int main(){
    fork();
    if(fork() && fork()){
        fork();
    }
    return 0;
}
```

Based on the above code snippet and considering none of the fork() calls in the parent and the child process fail, answer the following:

a) How many processes are created by this program? Explain in detail the logic behind your answer. **[2 + 8 Marks]**

b) Verify your answer in part(a) by adding appropriate *printf* statement(s) in the above code. Your program must compile without any error or warning in the CSX server. **[2 Marks]**

c) Draw the process tree diagram with **[5 Marks]**
   i) clearly specifying which node belongs to which fork in the code snippet. **[2 Marks]**
   ii) For the nodes which do not produce a child node, briefly specify the reason for not having any child node. **[3 Marks]**

4. Consider the following snippet of code in C:

```
int main(){
    int x = 5;
    fork();
    x++;
    fork();
    x--;
    fork();

    printf("Value of x: %d\n", x);
    return 0;
}
```

Based on the above code snippet and considering none of the fork() calls in the parent and the child process fail, what is the possible range of values that can be printed in the output for the variable 'x'? Clearly explain your reason in detail with a tree diagram, where each node needs to show the possible value(s) for variable "x". **[2 + 6 Marks]**

5. Consider the following snippet of code in C:

```c
void printProcessInfo(int processNumber) {
    printf("Process %d (PID: %d, Parent PID: %d)\n", processNumber,
getpid(), getppid());
}

int main() {
    printf("Root Process (PID: %d)\n", getpid());

    for (int i = 0; i < 3; i++) {
        if (fork() == 0) {
            // Child process
            printProcessInfo(i + 1);
        } else {
            // Parent process
            wait(NULL); // Wait for child process to finish
        }
    }

    return 0;
}
```

Based on the above code snippet and considering none of the fork() calls in the parent and the child process fail, draw the process tree diagram clearly showing the process ID and the parent process ID at each node in the tree. Assume the root process has a process ID of 1234. **[8 Marks]**

6. Consider the following snippet of code in C:

```c
int main() {
    int numForks = 3;

    for (int i = 0; i < numForks; ++i) {
        if (fork() && i % 2 == 0) {
            fork();
        }
    }

    printf("Hello\n");
    return 0;
}
```

Based on the above code snippet and considering none of the fork() calls in the parent and the child process fail, answer the following questions:

a) Draw the process tree diagram clearly showing the process ID and the parent process ID at each node in the tree. Assume the root process has a process ID of 4321. **[8 Marks]**

b) How many times the word “Hello” will be displayed. Give your reason. **[2 Marks]**

7. Consider the following snippet of code in C:

```
int main() {
    int variable = 5;

    fork();

    if (fork() == 0) {
        variable += 2;
    } else {
        wait(NULL);
        fork();
        variable -= 3;
    }

    return 0;
}
```

Based on the above code snippet and considering none of the fork() calls in the parent and the child process fail, draw the process tree diagram clearly showing the process ID and the parent process ID at each node in the tree. Also at each node, show the value of the "variable". Assume the root process has a process ID of 5521. **[8 Marks]**

Submission Guidelines:

- Submit a single pdf file with the name:
  - assignment01_lastName_firstName.pdf

- You need to submit the C file for questions 1, 2 and 3 and name the file as:
  - assignment01_lastName_firstName_ Question1.c
  - assignment01_lastName_firstName_ Question2.c
  - assignment01_lastName_firstName_ Question3.c

  - Note: Please make sure the submitted C files compile (without any warning) and run on the CSX server. If there is any error or warning during the compilation or at the runtime, 100% of the marks will be deducted for the given question.

- You need to include a single readMe.txt file which should include:
  - how to run your programs for question 1, 2 and 3 with detail instruction,
  - on which server the program is tested.

- In each .c file, use the following header information:
  - Author Name:
  - Email: <Use only official email address>
  - Date:
  - Program Description:
- Use comments throughout your program.