Boris Alarcon 3/26/2025

Operating System Midterm exam

1. For each of the following process state transition, say whether the transition is legal and how the transition occurs or why it cannot.
   1. Change from thread state WAIT to thread state RUNNING
      * + Illegal transition. A process can transition to a running state **only if** a process first transitions to the ready state to notify the CPU it’s ready to be scheduled to run and then ran. Skipping the ready state prohibits the CPU from caring about this process.
   2. Change from thread state RUNNING to thread state WAIT
      * + Legal transition. This transition occurs when a process requests/needs an I/O operation before continuing to run.
   3. Change from thread state READY to thread state WAIT
      * + Illegal transition. A process can **only** transition to a wait state after a CPU runs the process and encounters an I/O call or operation.
2. Write a program that opens a file (with the open () system call) and then calls fork () to create a new process. Can both the child and parent access the file descriptor returned by open ()? What happens when they are writing to the file concurrently, i.e., at the same time?
   * + - They both will have access to the file, but only one is able to write at a time. When writing concurrently, it will give the illusion that it is writing at the same time, but the CPU will just randomly be alternating its resources quickly among both.
3. Write another program using a fork (). The child process should print “hello”; the parent process should print “goodbye”. You should try to ensure that the child process always prints first; can you do this without calling wait () in the parent?
   * + - To do this, you might include a I/O request (ie. cin) in the parent’s fork so the process updates to a “WAITING/BLOCK” state and the CPU will switch its resources to the “READY” child process until the parent is “READY” again.
4. Write a program that creates a child process, and then in the child closes standard output (STDOUT FILENO). What happens if the child calls printf () to print some output after closing the descriptor?
   * + - After closing the standard output, the child will no longer have access to the descriptor and the content won’t be displayed. The parent will still have access to it though.
5. Consider the following piece of C code:

void main ( ) {

fork ( );

fork ( );

exit ( );

}

How many child processes are created upon execution of this program?

* + - * 3 child processes are created. This is because the first fork creates a parent0 and a child1, but the second fork is executed by both, which will make parent0 create another child2 and child1 will also create another child3. (order may vary because of parallel creation)

1. An interactive shell program such as bash shell (terminal in Linux and Mac) or PowerShell or CMD prompt in Windows takes command line input from the user and then execute the command/program specified by the user. In this exercise, you will implement closh (Clone Shell), a simple shell-like program designed to run multiple copies of a program at once.  
   Like any other shell, closh takes as input the name of the program to run (e.g.,  
   hello world). However, closh also takes two additional inputs:
2. The number of copies (processes) of the program to run. This is an  
   integer from 1 to 9.
3. Whether the processes should be executed concurrently or  
   sequentially, in sequential execution, the shell should wait for every  
   time a program is executed. In case concurrent execution, the shell  
   does not need to wait for the program to complete execution.

Closh executes the given program, the specified number of times, then  
returns to the prompt once all processes have either completed. Here is a  
simple example of using closh

(italic is user input and hello.exe is the hello world as in previous question):  
mint@mint:~$ ./closh  
closh> ./hello.exe  
count> 3  
[p]arallel or [s]equential> p  
hello world  
hello world  
hello world  
closh>

To write such a shell in C++, refer to the process lecture. As noted in the slide, you can use “execvp()” to create a new child process and have it execute a command. Use also the “waitpid” in the parent process to wait for the child process to finish in case sequential execution is selected.  
For simplicity, assume that the user specifies the full path name for any  
command/executable that they wish to execute. Thus, you do not need to deal  
with path name completion issues. You can test your shell on programs you  
write in C++ (after compiling to machine language).

https://github.com/alejos221/OS-Closh-Midterm-Assignment

Create a GitHub repository and upload this document with answers to question 1 and 6 with all your .cpp or .c programs. Copy the repository link and paste it in Canvas assignment.