CSSE 332 -- Operating Systems

Rose-Hulman Institute of Technology

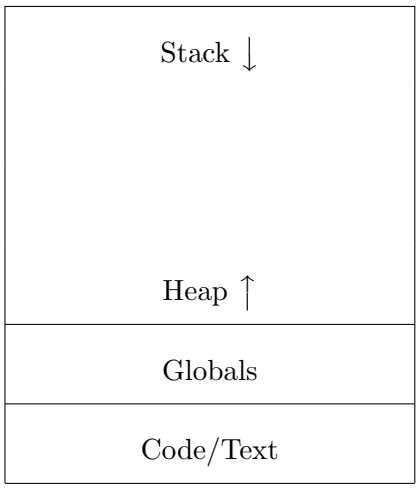
Introduction to Processes

Name: _____

Question	Points	Score
Question 1	5	
Question 2	5	
Question 3	5	
Question 4	5	
Question 5	5	
Question 6	10	
Question 7	5	
Question 8	5	
Question 9	10	
Total:	55	

Question 1. (5 points) The figure below represents the address space of a process `P`. Label each part of the process address space with its corresponding section content (i.e., stack, heap, etc.).

High Address



Low Address

Question 2. (5 points) When switching from one process to another to run on the CPU, what needs to be saved about the process so it can later on resumed?

Solution: We would need to save the program counter (`pc` register) as well as all of the process's registers. See the `struct trapframe` in `kernel/proc.h` for reference.

Question 3. (5 points) Describe how processes are related to each other in a Unix-like operating system.

Solution: There is one mother process (typically called `init` or depending on the system, `systemd`) that is initially created. All processes in the system are children (direct or indirect) of this process. It is like a big tree rooted at this `init` process.

Question 4. (5 points) How does a process keep track of who its direct parent is?

Solution: We maintain all of the information about a process in the process control block (`pcb`). In xv6, it is called the `struct proc` and is defined in `kernel/proc.h`. This is where we also store the process's trapframe, it is maintained in the kernel's memory space.

Question 5. (5 points) In RISC-V, the `ebreak` instruction is used to cause a context switch to the kernel to execute priviledged operations.

In the standard C library, the `fork` system call is used to create a new process by `duplicating` the calling process. The new process is called a **child** of the calling process. Finally, a process can use the `getpid` system call to obtain its process id.

Question 6. (a) (5 points) Where can you find the documentation for the `fork` system call? What is the command you can use to bring it up?

> **Solution:** The manual pages, using `man fork`.

(b) (5 points) From the documentation page, which header file should you include to use `fork`?

> **Solution:** `unistd.h`

Question 7. (5 points) Consider the code snippet below.

```
1 pid_t pid = fork();
2 if(pid == 0) {
3   printf("Hello from the child process %d\n", getpid());
4   exit(0);
5 } else {
6   printf("Hello from the parent process %d\n", getpid());
7   exit(0);
8 }
```

Which of the print statements will show up on the console first?

> **Solution:** We cannot know since we do not control which process runs at which time, even if we use `fork`.

Question 8. (5 points) Consider the code snippet below.

```
1 pid_t my_pid = getpid();
2 if(fork() == 0) {
3   printf("My pid is %d\n", my_pid);
4   exit(0);
5 } else {
6   printf("My pid is %d\n", my_pid);
7   exit(0);
8 }
```

Which of the following statements is **True**?

A. Each process will print its own process id.

B. Both processes will print the same value, which is the process id of the parent.

C. Both processes will print the same value, which is the process id of the child.

D. We cannot know what values will be printed in each case.

E. None of the above.

Question 9. (10 points) Consider the following snippet of code.

```
for(int i = 0; i < 3; i++)
  fork();
```

How many process will we end when this loop runs? Draw the corresponding tree of these processes.

Solution: We would end up with 2^3 processes since each new process will continue with the loop.