**Mid-Term Exam – Principles of Operating Systems**

**CSE 30341 – Spring 2017**

February 28th, 2017

The Notre Dame student handbook reminds our community of our shared purpose both within the institute of academia and as members of a broader humanity; the statement also outlines policy violation procedures.  Any questions regarding academic integrity, particularly regarding assignments in this course, should be directed to the instructors or TAs.

CODE OF HONOR PLEDGE

I will not give or receive aid on this examination.  This includes discussing the exam with students who have not yet taken it.  I understand that if I am aware of cheating on this examination, I have an obligation to inform Professor Thain or Professor Striegel. I also understand that Professor Thain or Professor Striegel will follow the University of Notre Dame Academic Code of Honor if either detects acts of academic dishonesty.

**Name** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (printed)

**Name** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (signed)

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Notes**

1. You will have 75 minutes to complete the exam starting promptly at 8:00 AM.
2. You may look at the exam and flip through it upon receiving the exam.
3. The exam is closed book, closed electronic device.
4. You may have up to one page of notes (front / back page of notes).
5. Write your answers **legibly**.
6. Pictures and labels matter more than long sentences of text.
7. Ask questions. When in doubt, please ask. You are probably not the only one with a question.

**Exam Score \_\_\_\_\_\_\_\_\_**

**Short Answer (5 points each)**

**Please note that we have provided additional space beyond what may be required to answer each of the following questions.**

1. Describe how an OS performs a context switch between two processes.
2. Describe the precise behavior and return values of the fork system call.  
   Use an illustration if appropriate to describe what fork does.
3. Sketch the major states a process can be in and indicate what events cause a transition between each state.
4. Explain the two operations that can be performed on a semaphore.

**Scheduling (10 points)**

Consider a single-CPU machine with a SJCT (Shortest Job Completion Time) scheduling policy. Suppose that processes are created in the system with the following arrival and run times:

|  |  |  |
| --- | --- | --- |
| **Process** | **Arrival Time** | **Run Time** |
| A | 0 ms | 100 ms |
| B | 0 ms | 50 ms |
| C | 20 ms | 20 ms |
| D | 50 ms | 100 ms |
| E | 80 ms | 50 ms |

Sketch out exactly when each process runs, and for how long, until all are complete.

You may assume the following:

* Context switching is instantaneous.
* The arrival of a new process forces a reschedule.
* Ties are resolved in favor of the process occurring earlier in the alphabet.

**Synchronization Problem (10 points)**

**The Barnyard Problem**

Suppose that you have one barn and a large number of goats and chickens.

* Up to **four** goats can be in the barn at once.
* **Any** number of chickens can be in the barn at once.

However, goats and chickens cannot be in the barn at the same time, otherwise they fight.

Solve this synchronization problem using pthread mutexes and condition variables. Assume that each animal is represented by a thread that calls goat\_enter(), goat\_leave(), etc whenever they desire to enter or leave the barn. A good answer can fit in the space available. It may also be beneficial to use comments or an explanation on the back for your answer.

Declare global variables here:

void goat\_enter() { void goat\_leave() {

void chicken\_enter(){ void chicken\_leave() {

**Deadlock (10 points)**

The Crazy Carpenters Problem:

A hammer (H), a saw (S), and a ruler (R) sit on a table in the carpenter’s union hall. Various carpenters walk into the hall and try to obtain the tools that they need for the next job. A given carpenter might need any one, any two, or all three of the tools. Each one picks up the needed tools one by one in a random order and leaves when they are satisfied. If a needed tool is not available, the carpenter will stop and wait (while still holding other tools) until it becomes available. When the job is done, they return the tools to the table.

A. Give a sequence of events that would result in deadlock.

B. State three distinct ways in which you could adjust the behavior of the carpenters so that deadlock is prevented.

1.

2.

3.