

CS 314 Operating Systems
Spring 2024
Quiz #5 on February 8, 2024 (**SOLUTIONS**)

Your Last Three Digits: _____
(please do NOT write all of your student ID or your name)

Grade: _____

(1) What is “a binary (or mutex) semaphore”?

A binary semaphore is a semaphore (a one-bit data structure managed by an operating system) which takes either ‘0’ or ‘1’.

(2) Explain how a semaphore can prevent race condition.

If a semaphore is initialized by ‘1’ (assume that each process performs “wait” operation to the semaphore), the semaphore allows at most one process enter a critical section at a time. Thus, a race condition is prevented.

(3) What “wait” system call to a semaphore exactly performs?

Wait

- If $S > 0$, do $S = S - 1$ then proceed
- If $S = 0$, wait on this semaphore

Note 1: Some students wrote “if no process is waiting” instead of “if $S > 0$ ”. That is not correct, since if a semaphore is initialized by ‘0’ (then, it is possible for S to be ‘0’ while no other process is waiting). For that particular case, “ $S = S - 1$ ” should not be performed.

Note 2: Some students wrote “if another process is waiting” instead of “if $S = 0$ ”. That is not correct, since if a semaphore is initialized by ‘0’, when a process performs “wait” to that semaphore, that process is still blocked even if no other process is waiting.

(4) What “signal” system call to a semaphore exactly performs?

Signal

- If no one waiting on S, set $S = S + 1$
- If some one waiting on S, let the first proceed to CS and leave $S = 0$

(5) What are “counting semaphores” (how are “counting semaphores” different from “binary (mutex) semaphores”)?

Counting semaphores are those initialized by an integer larger than ‘1’ (while binary (mutex) semaphores are always initialized by ‘1’). Thus, counting semaphores are used to allow a certain number of (multiple) processes to proceed, while binary (mutex) semaphores are for mutual exclusion (to prevent race conditions).