SYSTEMS EXAM

Spring 2022

90 minutes

Check which problems you are submitting:

- ❑ #1
- ❑ #2
- ❑ #3

How many pages total?_____

Please do not write on the back of any pages.

_____

(print name)

_____

(signature)

_____

(NetId)

1. **(20pts Total) Critical Section**

a) (4pts) List the **three** (3) standard goals of the **mutual exclusion** problem when there are two processes.

b) (8pts) Using the code below, state one goal that is **NOT** satisfied and provide an execution sequence that violates the goal.

c) (8pts) Using the code below, select one goal that **IS** satisfied and give a brief explanation that justifies why the goal is met for all possible execution sequences.

Assume a common variable: lock = false; and assume the existence of an atomic (non-interruptible) test_and_set function that returns the value of its Boolean argument and sets the argument to true.

```
//Process 1
while (true) {
   while(test_and_set(lock));
   Critical section;
   lock = false;
   Noncritical section;
}
```

```
Process 2
while (true) {
   while(test_and_set(lock));
   Critical section;
   lock = false;
   Noncritical section;
}
```

2. (20pts Total) Paging

Given the page reference string: 0 1 3 5 0 1 2 4 5 3 5 1

a) (10pts) Assume memory has 8 pages and there are 4 page frames. Using the **second chance page replacement (clock) algorithm**, fill in the table below. Show the marker bits as they change and indicate if a page fault will occur.

pages	**0**	**1**	**3**	**5**	**0**	**1**	**2**	**4**	**5**	**3**	**5**	**1**
Frame 0												
Frame 1												
Frame 2												
Frame 3												

b) (10pts) Assume memory has **8 pages** and there are **4 page frames**. We have a page reference string of **2,6,5,7** to fill the first 4 frames. Complete the tables below by adding **three more page references** that will result in **LRU** having **fewer** page faults than **FIFO.**

LRU

pages	**1**	**2**	**4**	**6**	**?**	**?**	**?**
Frame 0	**1**	**1**	**1**	**1**			
Frame 1		**2**	**2**	**2**			
Frame 2			**4**	**4**			
Frame 3				**6**			

FIFO

pages	**1**	**2**	**4**	**6**	**?**	**?**	**?**
Frame 0	**1**	**1**	**1**	**1**			
Frame 1		**2**	**2**	**2**			
Frame 2			**4**	**4**			
Frame 3				**6**			

3. **(20 pts Total) Mixed – Short answer**

a) (2pts) Name **two** (2) mechanisms that an applications programmer can use to ensure correct process **synchronization** when manipulating shared data?

b) (2pts) Name a **hardware** solution to the **critical section** problem.

c) (4pts) Define "**short-term scheduler**" and "**long-term scheduler**." Specifically, where do processes go when using each of these?

d) (4 pts) What is a **context-switch** and **name five (5) elements** of a process context switch.

e) (4pts) What would be the **implementation** of a **block** and **wait semaphore** and how is the **value** of any semaphore modified?

f) (4pts) A computer system has a **36-bit virtual address space** with a **page size of 8K**, and **4 bytes per page table entry**. How many **pages** are in the virtual address space? What is the **maximum size** of addressable **physical** memory in this system?