## SYSTEMS EXAM Spring 2022 90 minutes

Check which problems you are submitting:

$$
\begin{array}{ll}
\text { 口 } & \text { \#1 } \\
\text { } & \# 2 \\
\text { \# }
\end{array}
$$

How many pages total?
Please do not write on the back of any pages.
(print name)
(signature)
(Netld)

## 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: 013501245351
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 <br> 0 |  |  |  |  |  |  |  |  |  |  |  |  |
| Frame <br> 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| Frame <br> 2 |  |  |  |  |  |  |  |  |  |  |  |  |
| Frame <br> 3 |  |  |  |  |  |  |  |  |  |  |  |  |

b) (10pts) Assume memory has 8 pages and there are 4 page frames. We have a page reference string of $\mathbf{2 , 6 , 5 , 7}$ 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 | $\mathbf{2}$ | 6 | 5 | 7 | $?$ | $?$ | $?$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Frame 0 | 2 | 2 | 2 | 2 |  |  |  |
| Frame 1 |  | 6 | 6 | 6 |  |  |  |
| Frame 2 |  |  | 5 | 5 |  |  |  |
| Frame 3 |  |  |  | 7 |  |  |  |

FIFO

| pages | 2 | 6 | 5 | 7 | $?$ | $?$ | $?$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Frame 0 | 2 | 2 | 2 | 2 |  |  |  |
| Frame 1 |  | 6 | 6 | 6 |  |  |  |
| Frame 2 |  |  | 5 | 5 |  |  |  |
| Frame 3 |  |  |  | 7 |  |  |  |

## 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 8 K , 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?

