

COM S 352: Introduction to Operating Systems
Midterm Practice Exam
Fall 2023

Cover Sheet

Student Name: _____

Format:

- Time: 50 mins
- Points: 100
- Question Types: matching, true/false and short answer

Instructions:

- You may use 1 (one) letter sized sheet of paper (front and back), that you have prepared yourself with notes before the exam, as a "cheat sheet" during the exam.
- You may not consult classmates, electronic devices or resources other than the cheat sheet during the exam.
- Questions of clarification should be asked directly to an instructor or TA.

Question	Points
1	/24
2	/30
3	/10
4	/10
5	/6
6	/6
7	/10
8	/4
Total	/100

1. (24 pts, 3 pts each) For each description on the left, select the best matching term on the right, each term is used only once but some will not be used.

_____ makes a copy of the current process

_____ a process that frequently exceeds its time slice

_____ mechanism that can provide both locking and signaling

_____ created as a result of calling `pthread_create()`

_____ system calls are implemented using traps because they require this

_____ a queue for inter-process communication

_____ reason caching can improve performance

_____ machine instruction that can be used to implement mutex locks

- a. CPU bound
- b. TestAndSet
- c. Heap
- d. TCB
- e. kernel mode
- f. page out
- g. pipe
- h. semaphore
- i. fork()
- j. swap
- k. MMU
- l. locality

2. (30 pts, 2 pts each) Which of the following statements are true? Write T or F for true or false.

_____ In RR scheduling, best performance is when the time quantum is small with respect to context-switch time.

_____ In the Linux Completely Fair Scheduler processes with low nice values always run before those with high nice values.

_____ LRU never experiences Belady's Anomaly.

_____ The purpose of priority boost is to prevent starvation.

_____ A context switch is preformed when changing a process from the blocked state to ready state.

_____ Thrashing is a result of insufficient multiprogramming.

_____ A segment can be shared by multiple processes.

_____ If a page's contents in memory are different than they are on disk, the valid bit must be set to invalid.

_____ An illegal memory access results in a page fault.

_____ A translation lookaside buffer (TLB) is used to search for free space in physical memory.

_____ Paging has the problem of internal fragmentation.

_____ Tick based Operating Systems depend on a hardware interrupt to keep track of time.

_____ The bounded-buffer problem can be solved using only semaphores to control concurrency.

_____ A binary semaphore is equivalent to a mutex lock.

~~_____ A thread requesting a resource never causes a deadlock as long as that thread does not currently have any other resources assigned to it.~~

3. (10 pts) Consider the following set of jobs, with arrival times and the length of CPU bursts given in milliseconds.

	Arrival Time	CPU Burst
A	0	10
B	1	12
C	4	10
D	5	2

Create Gantt charts and compute the average response time for each of the following scheduling algorithms. Show your calculations.

a) SJF (without preemption)

Gantt chart:

Average response time is _____ (show calculation below)

b) STCF

Gantt chart:

Average response time is _____ (show calculation below)

4. (10 pts) Given the reference string of page accesses: 4 3 2 1 4 3 5 1 and a system with 3 page frames, how many page faults result when using the following page replacement policies? Show your work.

a) FIFO

Number of page faults is _____ (show work below)

b) OPT

Number of page faults is _____ (show work below)

5. (6 pts) The code for the xv6 kernel function sched() is provided below.

```
void
sched(void)
{
    // ...
    struct proc *p = myproc();
    // ...
    swtch(&p->context, &mycpu()->context);
    // ...
}
```

Why does the function call swtch()? What does swtch() do? Answer in 2 to 3 sentences.

6. (6 pts) Given a virtual address space of 1,024 pages and a 4,096 byte page size, how many bits are required to store a virtual address. Show calculations.

7. (10 pts) Consider two threads `ping_thread` and `pong_thread` that output the words “ping” and “pong” respectively. The required output of the program is as follows (it is required that ping always goes first):

```
ping
pong
ping
pong
...
```

Provide a solution for `ping_thread` and `pong_thread` **using only semaphores** for concurrency control. Declare and initialize all variables. Exact `pthread` syntax is not required.

```
#include <pthread.h>

// declare any required variables here


void init() { // perform initialization here


}

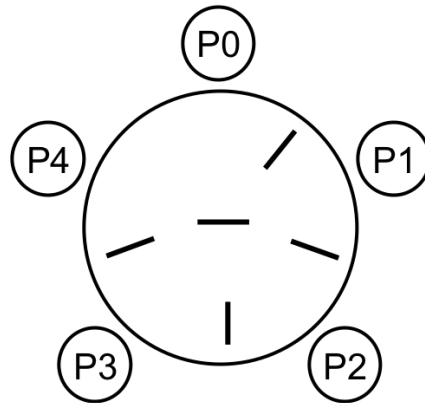

void* ping_thread(void *arg) {
    while (1) { // complete the ping thread


    }
}


void* pong_thread(void *arg) {
    while (1) { // complete the pong thread


    }
}
```

8. (4 pts) Consider a modified version of the dining philosophers problem, where one of the chopsticks is placed at the center of the table, available for any of the philosophers to pick up with either hand.



Can deadlock be prevented if no philosopher is allowed to pick up the center chopstick as their first chopstick? Explain your answer.